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THE DEPARTMENT OF MOLLUSKS
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MONOGRAPHS OF THE MARINE MOLLUSKS OF THE WESTERN ATLANTIC

VOLUME IV
NUMBERS 40-48

Edited by
WILLIAM J. CLENCH
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PRINTED AT
BOTANICAL MUSEUM OF HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS
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RICHARD WINSLOW FOSTER

1920-1964

Research Assistant, Department of Mollusks, Museum of Comparative Zoology
1942-1945

Assistant Curator, Department of Mollusks, Museum of Comparative Zoology
1945-1949

Associate in Mollusks, Department of Mollusks, Museum of Comparative Zoology
1949-1964

President, Boston Malacological Club
1948-1949; 1960-1962

RICHARD WINSLOW FOSTER

June 20, 1920–September 3, 1964

On September 3, 1964, the Department of Mollusks, Museum of Comparative Zoology, lost an enthusiastic worker, friend, and benefactor, when Richard Winslow Foster, Associate in Mollusks, died in Rome, Italy. It is particularly appropriate to dedicate this volume of *JOHNSONIA* to Mr. Foster because it was his donation that enabled Dr. Clench to commence publication of this series of monographs.

Richard Foster, the son of Frederick William Choate Foster and Mable Winslow Foster, was born on January 20, 1920. During his boyhood, the family lived at 'Sevenels' on Heath Street, Brookline, Massachusetts, the house made famous by the Lowell family, and summers were spent at Pleasant Bay, South Orleans, Massachusetts. Dick particularly enjoyed his summers on the Cape and it was there that he developed his love of natural history. Although he was interested in plants and animals, his chief interest was in mollusks, particularly marine shells. He first visited the Museum of Comparative Zoology in September 1934 when he was 14 years old, but earlier he had gone to the museum of the Boston Society of Natural History, where he knew Mr. S.N.F. Sanford, Curator of Invertebrates, for whom he often collected specimens. At this time Dick wrote long letters to Dr. Clench about his attic lab at the South Orleans home, his library, the \$14.50 microscope he had purchased at the age of ten from Sears Roebuck and Co., and the survey he was making of Pleasant Bay. He kept detailed notes, was always scientific in his approach and never used common names for the specimens he collected. He became a member of the Boston Malacological Club in 1933 and in 1935 attended the convention of the American Malacological Union at Buffalo, New York. From the time of his earliest association with the Mollusk Department of the Museum of Comparative Zoology he contributed much of his time and all of his best material to its collections.

During a school vacation in March 1934 he made a trip to Ormond Beach, Florida, his first to a subtropical area. In January 1935 he became a student at the Adirondack-Florida School in Coconut Grove, Florida. The fall and spring terms of this school were held in the Adirondacks and the winter term in Florida. This allowed Dick to meet many of the Florida collectors and he rapidly picked up a knowledge of field techniques and Florida shells. During the summer of 1936 he made his first trip to the Bahamas.

In September 1936 he transferred to Milton Academy, Milton, Massachusetts where he came under the influence of the physiologist Dr. Albert Navez, with whom he worked at the Woods Hole Marine Biological Laboratory during the summer of 1938. He co-authored a paper with Navez on the cardiac rhythm in *Pecten irradians* Lamarck.

Mr. Foster entered Harvard College in September 1938 as a member of the class of 1942. However, because of the death of both of his parents in 1941, he left college, and in May of that year went on an expedition to the Bahama Islands with John Huntington.

He spent the war years doing research for the Navy on underwater sound. Most of this work was done in Florida where he had an opportunity to use some of the early self-contained diving equipment and to spend many week ends collecting shells. During July and August of 1944 he joined Mr. and Mrs. Leo A. Burry on a dredging trip off the

lower Florida Keys. They made about 40 stations and collected approximately 4000 lots of over 300 species. After the war he returned to Harvard, completed his undergraduate work and received his A.B. degree in 1950. For a time he was active with the Massachusetts Department of Commerce when it was endeavoring to attract new electronic businesses to the state. He also worked for a short period with Arthur D. Little Company while still maintaining connections with the museum, and returned on a full time basis in 1953.

In 1950 he went on the first of a series of extended field trips and expeditions which took him to Trinidad and Tobago; Bermuda (1951), the Virgin Islands and Lesser Antilles (1958). In 1960-61 he went to Madagascar and in 1962, to the Cook Islands and Viti Levu in the Fiji Islands. Both of these were joint expeditions with the Academy of Natural Sciences of Philadelphia. He joined the R/V CHAIN, Cruise 35 to the South Atlantic, Brasil and the north coast of South America in 1963. Also in that year he was on the R/V ANTON BRUUN, Cruise 4-B to the Indian Ocean and Gulf of Aden. He was on his way to join the ANTON BRUUN for another cruise in the Indian Ocean when he was stricken in Italy and died following an emergency operation for appendicitis. As a result of these trips and his incidental collecting he was directly responsible for the addition to the mollusk collection of the Museum of Comparative Zoology of some 20,000 lots of well documented and very valuable specimens, many of which are preserved in alcohol.

Besides contributing his time, curatorial skills and specimens, he was responsible for much of the growth of the departmental library. He not only helped with cataloging, and paid for much of the bookbinding, but he was also the gracious donor of many of the standard as well as old and rare books on mollusks. Over the years he continued to support departmental publications and activities, helping graduate students with travel money, purchasing supplies or paying a collector in some remote area to obtain needed material. When the museum acquired a large collection, such as that of C. B. Adams or the collection of mollusks from the Peabody Museum of Salem, he was always willing to assist in the packing, transferring, and curating of this material.

Dick often wrote down his thoughts and plans, and in one of the notations found in his files, he expressed his feelings about a museum. "If a museum is to be a dynamic organism, its purpose must be to aid in the increase and diffusion of knowledge, and to be of assistance to all people who come to it for help." These goals, he said, could be achieved through research, the building and curating of the collections so that they "may be utilized easily by investigators, and through giving encouragement, as well as material and intellectual aid, to all scientific men, potential students and laymen." He completely lived these ideas, especially the aiding of others in their research. He will always be remembered as an excellent field man, an ardent curator and a generous benefactor who, through his kindness, was indirectly responsible for a large amount of published research.

—R. D. TURNER



On a field trip to St. Andrews, New Brunswick in 1963 (photo by P. Morse).



Sorting a fabulous haul on board the R/V ANTON BRUUN Cruise 4B, off Saudi Arabia.

Publications of Richard W. Foster

- 1935. *Arca barbatia* Linn. *Nautilus* 49: 64.
- 1937. Notes on *Anomia aculeata* Muller. *Nautilus* 50: 102-103.
- 1938. Cardiac rhythm in *Pecten irradians* Lamarck. *Biological Bulletin* 75: 371 (with A.E. Navez and J.D. Crawford).
- 1945. The Museum of Comparative Zoology-Burry Marine Museum Expedition of 1944. *Annual Report American Malacological Union* for 1944, p. 5.
- 1946. The genus *Mya* in the Western Atlantic. *Johnsonia* 2: 29-35, pls. 17-21.
- 1946. The Family Haliotidae in the Western Atlantic. *Johnsonia* 2: 36-40, pls. 22-23.
- 1947. *Cassis tuberosa* feeding on an echinoid (*Clypeaster rosaceus* L.). *Nautilus* 61: 35-36.

CONTRIBUTORS

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William J. Clench	40, 42, 43, 48
Arthur S. Merrill	44
Ruth D. Turner	Intro., 40, 41, 43, 48

* * * * *

ACKNOWLEDGMENTS

As with past volumes we are grateful to a large number of persons and institutions who have donated or loaned much of the material on which these studies were made. We are also grateful to many friends who have assisted by critically reading the manuscripts and particularly to Howard J. Allgaier, our printer, whose interest over the years has contributed so much to the fine format and appearance of JOHNSONIA.

* * * * *

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ANALYSIS OF SPECIES AND SYNONYMS

In the Introduction to Volume 3 we made a comparison of the number of synonyms per recognized Western Atlantic species considered in the first three volumes. An analysis of Volume 4 agrees closely with the results of the earlier volumes as shown in the following table.

Vol.	no. species	synonyms	ratio
I	210	338	1.61
II	169	247	1.47
III	59*	141	2.39
IV	124	192	1.55
Total	562	918	1.63

* *Johnsonia* numbers 33 and 34 included Eastern Pacific as well as several Eastern Atlantic species of *Pholadidae* and these are not included in the table.

It is interesting to note that species with the largest number of synonyms are either: 1) common, widely distributed and intertidal; 2) attached or boring; 3) beautiful, conspicuous and much sought after by collectors. The largest number of synonyms for a single species was 35 for *Martesia striata* Linnaeus, a wood boring bivalve. Of the 562 species and subspecies considered in the four volumes, 306 had no synonyms and of these 89 were described as new.

Analysis of Volume 4 shows that the fewest number of synonyms was found in *Callostoma* (41 species, 25 synonyms), a genus confined mainly to deep water and one on which little work had been done previously. The largest number of synonyms was found in *Lithophaga* (5 species, 20 synonyms), a genus of littoral, rock, shell, and coral boring species. Some species in the *Volutidae* (no. 43), a family of large, beautiful species, also have a fairly high number of synonyms with some 31 names applied to 10 species. The genus *Tellina* with 45 species and 63 synonyms shows a similar pattern with the shallower water, more readily available and usually more variable species having the largest number of synonyms.

It would appear, therefore, that as work continues, the ratio of synonyms to species will fluctuate depending upon the group being considered, but the average will probably remain about 1.6 to 2 synonyms per species.

* * * * *

ERRATA

No. 42, p. 122, the second entry in the synonymy of *Laemodonta* Philippi should read: '*Plecotrema* H. and A. Adams 1853 [1854]' and under *Plectotroma* 'Adams' Weyenbergh 1875 it should read: '[error for *Plecotrema* H. and A. Adams]'.

No. 42, p. 123, under *Laemodonta* (*Bullapex*) *cubensis* Pfeiffer, add the original reference: *Plecotrema cubensis* Pfeiffer 1854, Malakozoologische Blätter 1: 153 (Cardenas, Cuba).

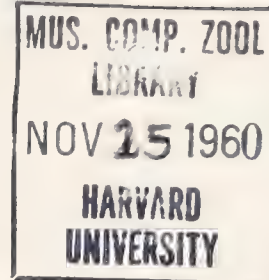
No. 43, p. 140, delete the name *Voluta fulva* Lamarck from the synonymy of *V. musica* Linnaeus. It is correctly given as a synonym of *V. virescens* Solander on p. 146.

No. 45, plates 141 and 142 are reversed.

Pages i-viii published June 29, 1970.

JOHNSONIA

Published by
THE DEPARTMENT OF MOLLUSKS
Museum of Comparative Zoölogy, Harvard University
Cambridge, Massachusetts



NOVEMBER 25, 1960

TROCHIDAE

VOL. 4, NO. 40*

THE GENUS *CALLIOSTOMA* IN THE WESTERN ATLANTIC

BY

WILLIAM J. CLENCH AND RUTH D. TURNER

The genus *Calliostoma* in the broad sense is nearly world wide in distribution, extending from the boreal to the austral seas and probably into the Arctic and Antarctic Oceans. Various species occur from the intertidal area to depths of several hundred fathoms.

The Western Atlantic is exceedingly rich in species as this present study indicates. It is, however, unfortunate that several are known only from single or at best, only a few specimens. Very little is known about their life history. All are presumed to feed on plant material such as various kinds of algae and diatoms; the deep water forms on plant detritus. Several genera and subgenera have been proposed to group certain of the many species in this large genus. Most subgenera have been based on rather trivial differences in the shell morphology such as separating the umbilicate forms from those which have an umbilical pad. In this way, closely related species are separated and in many cases

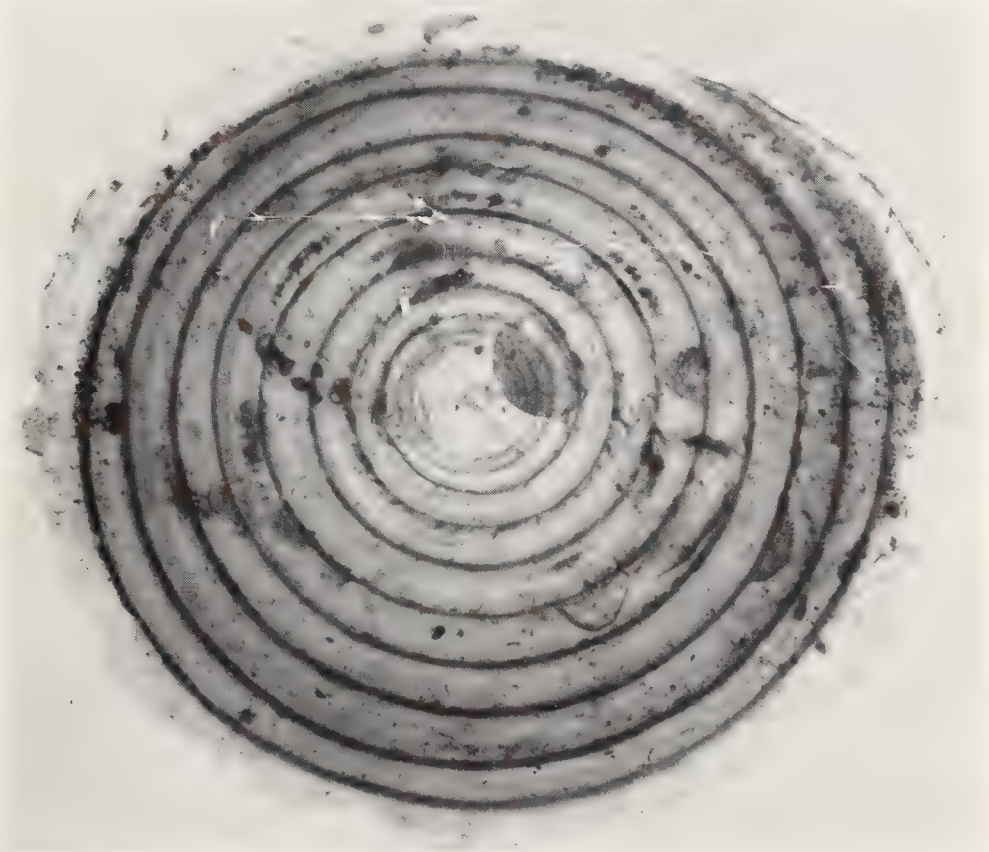


Plate 1. Operculum of *Calliostoma zizyphinum* Linné (13.6x). From Millport Harbour, Scotland.

* *Johnsonia*, Volume 4, starts with Number 40.

distantly related forms are brought together. In a few instances, the young may be umbilicate while the adults of the same species are imperforate.

Our studies of the jaws and radulae have shown that there are at least three rather distinct categories in which many of the Western Atlantic *Calliostoma* may be placed. Unfortunately, the soft parts of several species were not available so that the subgeneric placement of these species must be left until material is available. We feel, that at this time, a conservative attitude should be taken regarding the Western Atlantic *Calliostoma*, particularly on the generic level. To make several genera out of the many species groups based on the characters of the shell morphology would be meaningless and would confuse rather than expedite their classification. Certainly, characters of the shell are very important on a specific level but these same characters fail to meet the differences expected between genera.

In a few reports which include *Calliostoma*, a family name has been indicated, Calliostomidae. At this time this would appear to be unjustified as we still lack anatomical data on most genera in the Trochidae. In general, families are based upon characters which are rather sharply differentiated from one another and these characters may be based on such things as shell morphology or on significant differences in the soft anatomy. In the present case, *Calliostoma* is not at all sharply differentiated from many other genera in the Trochidae. In fact, there are several species described as *Calliostoma* which are now allocated to other genera. As far as we can trace, no one has set the limits of the

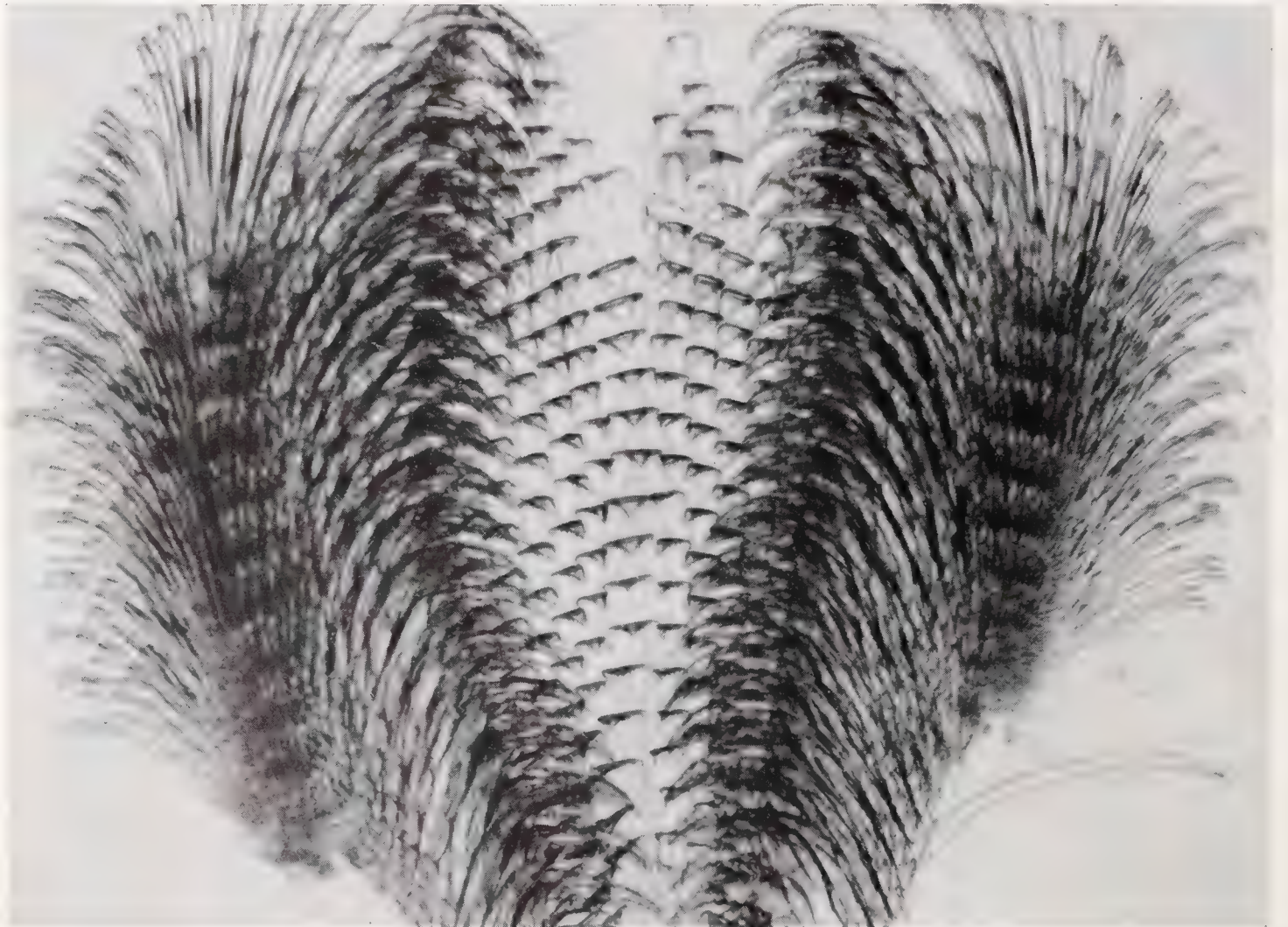


Plate 2. A whole mount of a section taken from the middle of the radular ribbon of *Calliostoma oregon* Clench and Turner, to show the complexity of the teeth and their arrangement. The first row of marginal teeth are completely covered other than a single tooth at the top and near the right center (52.5x). From the *Oregon*, station 550, about 70 miles SE of Corpus Christi, Texas.

family Calliostomidae. It is probably equal to what Wenz has considered on the family level.

Little is known of the anatomy of *Calliostoma* and unfortunately the material we had for study was not sufficiently well preserved for detailed anatomical work, though we were able to obtain the radulae and jaws from 20 species, 16 of which are illustrated. The jaws are most interesting and seem to be composed largely of organic material. They can only be obtained satisfactorily by dissection. If the entire head region is placed in potassium hydroxide for the extraction of the radular ribbon the jaws are reduced to a thin film which lacks all scales and other important characters. The jaws as illustrated have been removed from the membranes in which they are normally held and are spread out flat for photographing. The anterior end is uppermost. Normally the two small central plates are dorsal; the large plates extend down on either side of the odontophore and are connected by a membrane ventrally to form a tube. This chitin-like membrane extends anteriorly beyond the jaws in a ruffled tube. A portion of this tube remains and can be seen on Plate 10, fig. 1. Exactly how the jaws function we do not know but possibly they only hold the mouth open, though there might be some slight lateral scraping or gathering of food particles. Certainly they are not strong enough for actually biting off particles of food.

The jaws in the material studied may be grouped into three distinct types.

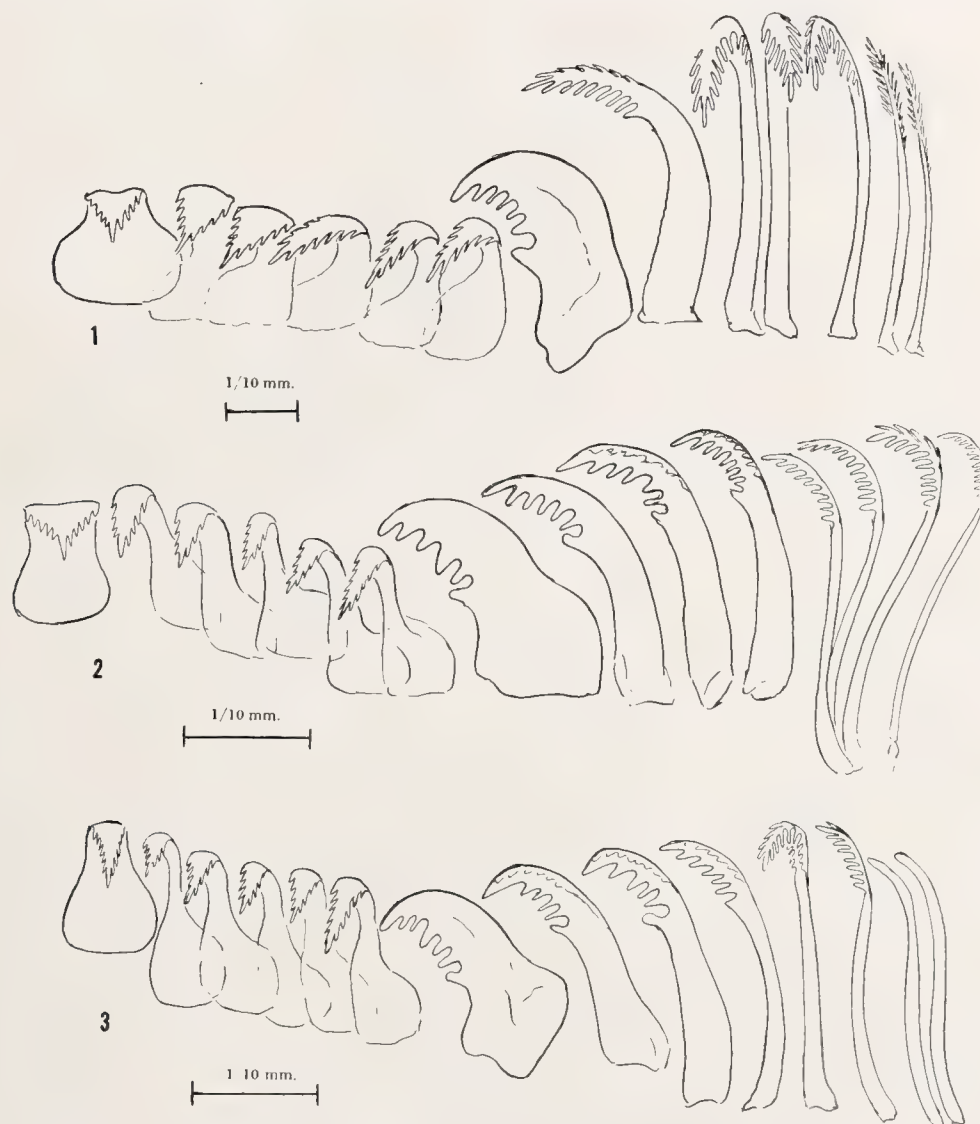


Plate 3. Radulae. Fig. 1. *Calliostoma zizyphinum* Linné, Millport Harbour, Scotland. Fig. 2. *C. jucundum* Gould, off Río de la Plata, Argentina. Fig. 3. *C. pulchrum* Adams, Bahía de Cárdenas, Matanzas, Cuba.

The first (*Calliostoma* ss.) has rather thin, straw-colored, rounded jaws with distinct and relatively large scales and, on the anterior edge, the scales are elongate, extending anteriorly as a fringe. This fringe can best be seen by using transmitted light and does not show well in all of the photographs (Plate 8).

In the second group (subgenus *Elmerlinia*) the jaws are somewhat pointed at the anterior end, the scales on the surface of the jaws are large and at the anterior end the scales are very long and project in tufts (Plate 9).

The third group (subgenus *Kombologion*) has rounded jaws that are rather thick, heavy, and dark brown in color, with very minute scales and a nearly smooth anterior edge without a true fringe (see Plates 10 and 11).

The radula of *Calliostoma*, as in all Archaeogastropoda, is very complicated, adapted for feeding on minute particles scraped from the surface of algae or, in the deep water forms, probably for gathering detritus. We have found minute particles of shells, sand grains and what appeared to be worm tubes filling the posterior end of the intestine in several deep water species. The radula probably acts mainly as a conveyor belt to carry the food into the mouth. Certainly the teeth are not strong enough, except possibly the first two marginal teeth, to be efficient rasps. Plate 2 shows a transverse section taken from the middle portion of the radular ribbon of *Calliostoma oregon* Clench and Turner. It is typi-

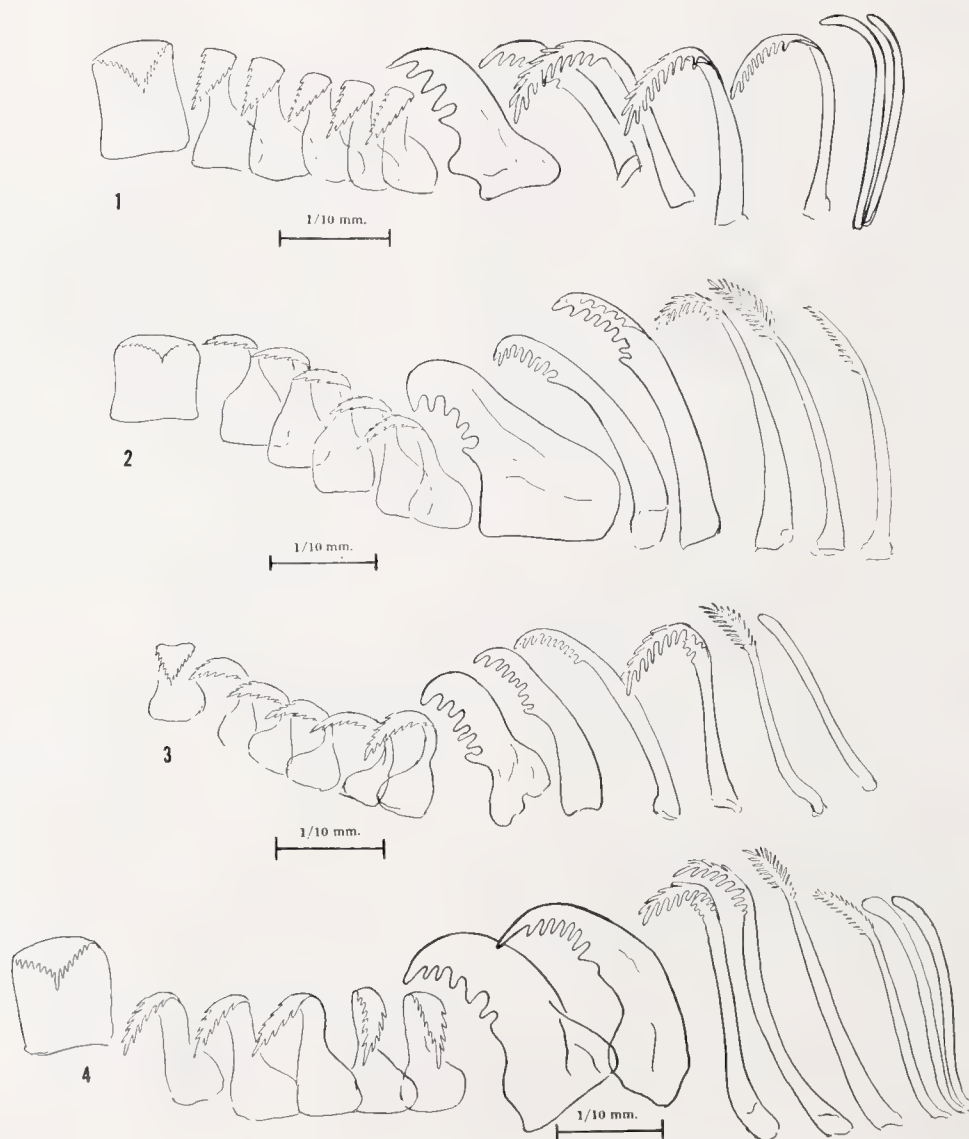


Plate 4. Radulae. Fig. 1. *Calliostoma coppingeri* Smith, from the *Hassler*, station 27, about 60 miles E of Peninsula Jabalí, Argentina. Fig. 2. *C. occidentale* Mighels and Adams, Eastport, Maine. Fig. 3. *C. roseolum* Dall, SW of Tortugas, Florida. Fig. 4. *C. yucatecanum* Dall, off Port Isabel, Texas.

cal of the genus and may be used as the basis for the discussion of various types of radulae found in the Western Atlantic *Calliostoma*. It will be noted that the central tooth is fairly broad, though weak, with a single large cusp which is finely serrated. The lateral teeth are quite similar to the central tooth and this produces a broad "low" central portion extending the length of the ribbon. The first marginal tooth, however, is large, strong and heavy. In the photograph (Plate 2) only a single first marginal can be seen at the top right hand side of the center, the others being covered by the overlapping marginals. The second marginal (in all Western Atlantic forms studied) is somewhat similar to the first though less powerful and never with as heavy a basal area. Beginning with the third marginal tooth, the remainder are very long, with numerous large serrations. The marginal teeth gradually diminish in size and often the outermost marginals are nearly or quite smooth. After studying the radulae of several species and several specimens of a single species from a single locality, as well as various portions of a single radular ribbon, it became apparent that the number of serrations on a given tooth varied considerably and could not be used as a taxonomic character. The number of marginal teeth varied in different specimens from the same locality and even in different portions of the same ribbon, and so could not be used. The number of lateral teeth, however, was constant for a given species, though not for the genus. The number of laterals varied from 4 to 7 with most species having 5. The proportional size and shape of the first marginal tooth varied considerably from one species to another. Though the first marginal tooth is always large, in *Calliostoma* ss. it is very heavy and has a large thick base (see Plates

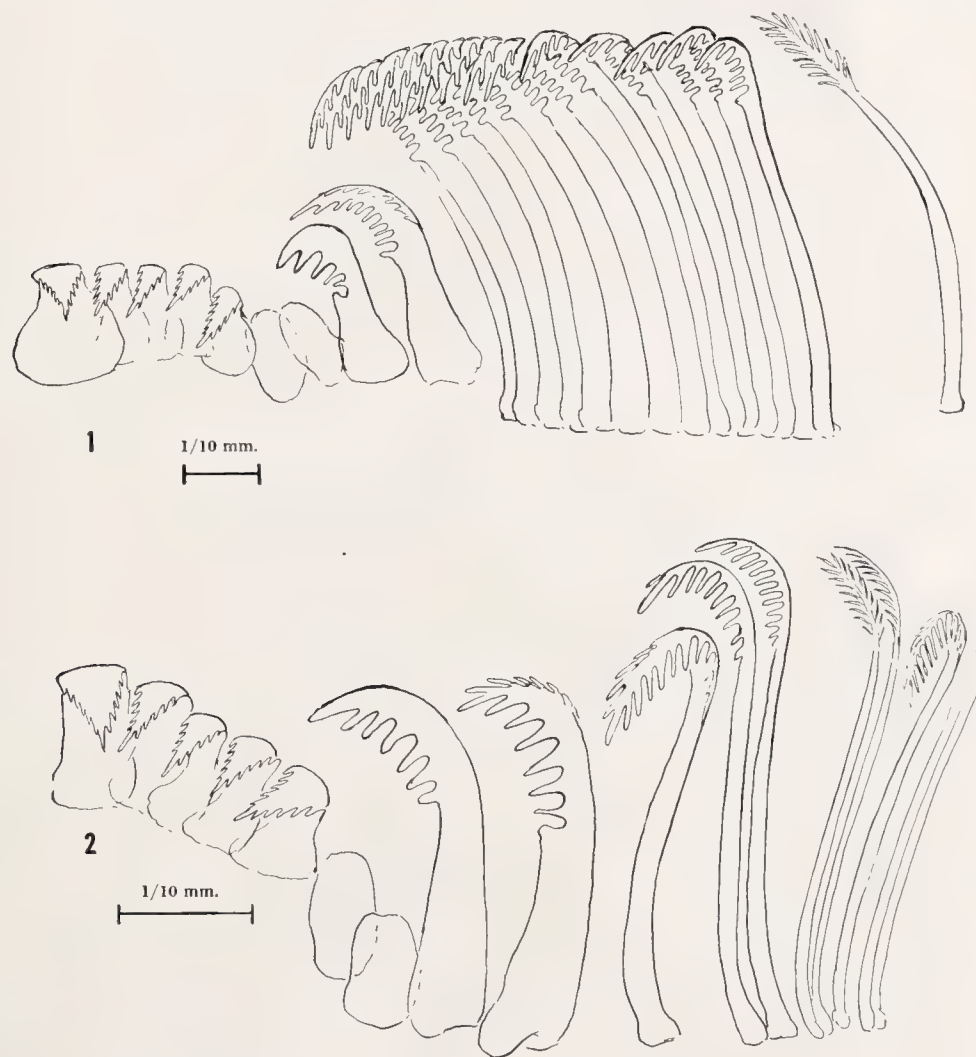


Plate 5. Radulae. Fig. 1. *Calliostoma bullisi* Clench and Turner, from the *Oregon*, station 2054, about 65 miles ESE of Cabo Orange, Amapá, Brasil. Fig. 2. *C. jujubinum* Gmelin, Marco, Florida.

3 and 4). It is very prominent and, because the remaining marginals are proportionally shorter, it is not covered by the overlapping marginals as in Plate 2. In the subgenus *Kombologion* the first marginal tooth, though somewhat of the same shape as in *Calliostoma* ss., lacks the heavy base and is much less conspicuous as is shown in Plates 2, 6 and 7. In the subgenus *Elmerlinia* the first marginal is similar to that in *Kombologion*, but the radula differs by having the two outer lateral teeth reduced to a large flat plate-like structure lacking cusps or having very long slender cusps as shown in Plate 5.

When arranging the species we have placed in subgenera those for which we had radulae and jaws; the remaining we have left only in the genus *Calliostoma* and these will be placed in the appropriate subgenera as soon as material is available.

Several species of Western Atlantic *Calliostoma* have been placed in the subgenus *Astele* Swainson, but the examination of the jaws and radula of *C. subcarinatum* Swainson, the type species of *Astele*, showed it to have a very different type of radula. (See under notes.)

The operculum in *Calliostoma* appears to be very uniform and shows but slight if any

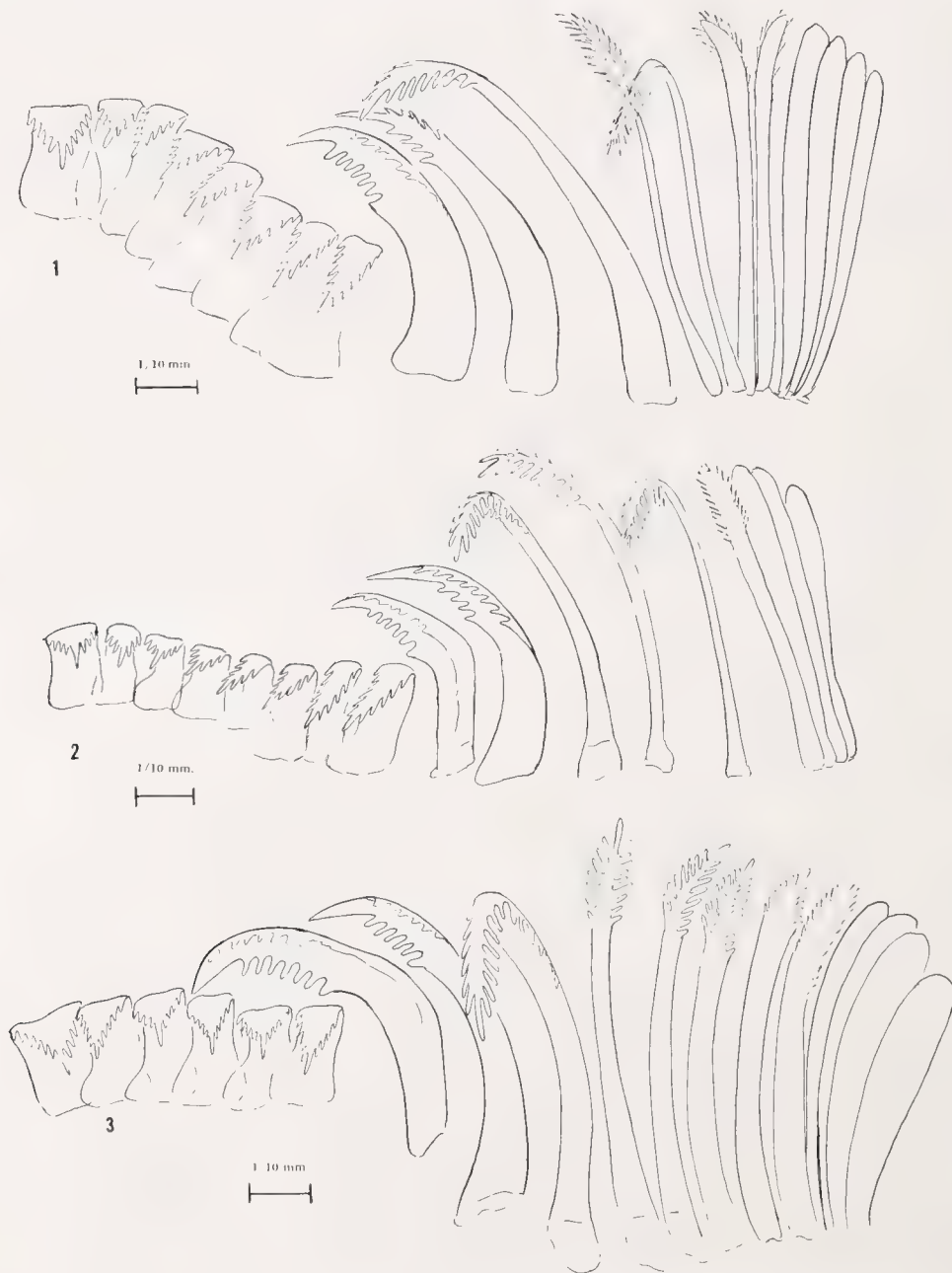


Plate 6. Radulae. Fig. 1. *Calliostoma bairdii* Verrill and Smith, about 120 miles E of Barnegat Bay, New Jersey. Fig. 2. *C. oregon* Clench and Turner, about 70 miles SE of Corpus Christi, Texas. Fig. 3. *C. rosewateri* Clench and Turner, about 90 miles SE of Galeota Point, Trinidad.

differences between the species. In fact, the opercula of all of the Trochidae are very uniform so far as we know, differing mainly in size, number of whorls and somewhat in color (see Plate 1).

The dominant sculpture in this genus consists of cords or ridges which may be smooth or beaded and which are separated by grooves or incised lines. The beading, when present, is fairly uniform on any one cord, but the size of the cords and consequently the beading may vary greatly at different levels of the whorl. Variation is also expressed in

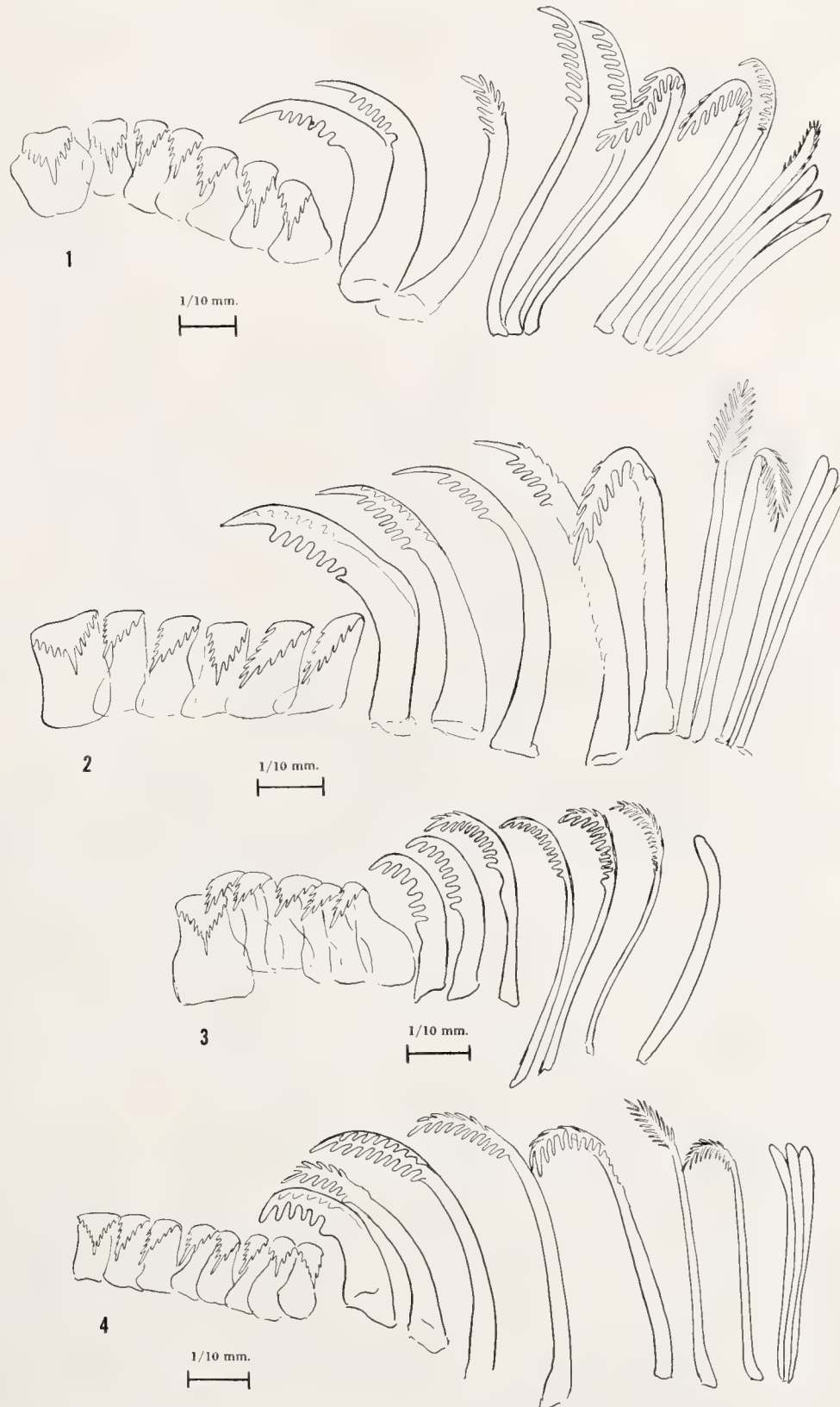


Plate 7. Radulae. Fig. 1. *Calliostoma psyche* Dall, from the *Combat*, station 91, about 60 miles E of Daytona, Florida. Fig. 2. *C. schroederi* Clench and Aguayo, from the *Combat*, station 235, off Matanilla Shoals, Little Bahama Bank, Bahama Islands. Fig. 3. *C. marionae* Dall, from the *Combat*, station 101, about 50 miles E of St. Augustine, Florida. Fig. 4. *C. hendersoni* Dall, from the *Oregon*, station 1349, about 8 miles NE of Cay Sal Bank, Bahama Islands.

the average number of cords characteristic of a given species, but specimens of a single species will show some variation in the number of cords and in the size of the beads. In species which have a reduced number of cords, those remaining are usually at the periphery of the whorl; the area near the suture or the columella is often smooth. In many species there are one or two cords at the periphery which may or may not be beaded and which are usually larger than the other cords.

In the descriptions of several species of deepwater *Calliostoma* described by Dall, he mentions that the embryonic whorls are sinistral. His most pertinent note on this character is under *C. roseolum* Dall (1889, Bull. Museum of Comparative Zoology 18: 366). We have examined all of Dall's holotypes and in no case have we found the nuclear or embryonic whorls sinistral. All appear dextral. All of the various *Calliostoma* larval shells studied by Lebour are dextral. The embryonic whorls are small and are somewhat flattened, but the direction of coiling is apparent even under moderate magnification (14× to 20×).

Little is known of the embryology and development of the many species of *Calliostoma*. Jeffreys (1865) was the first to mention that the fry of *millegranus* and *zizyphinus* were slightly umbilicate. Roberts (1902) in his paper on the development of the Trochidae described the eggs, cell lineage, and early development of several species in this family and illustrated the veliger larvae of *Trochus striatus* (= *Calliostoma*) and young of *C. canuloides* and *C. magus*. Lebour (1936) described and figured the young of *Calliostoma zizyphinus* Linné which spawned in the tanks at the marine laboratory in Plymouth, England. The eggs were laid in a gelatinous ribbon, several inches long and 3 or 4 mm. wide.

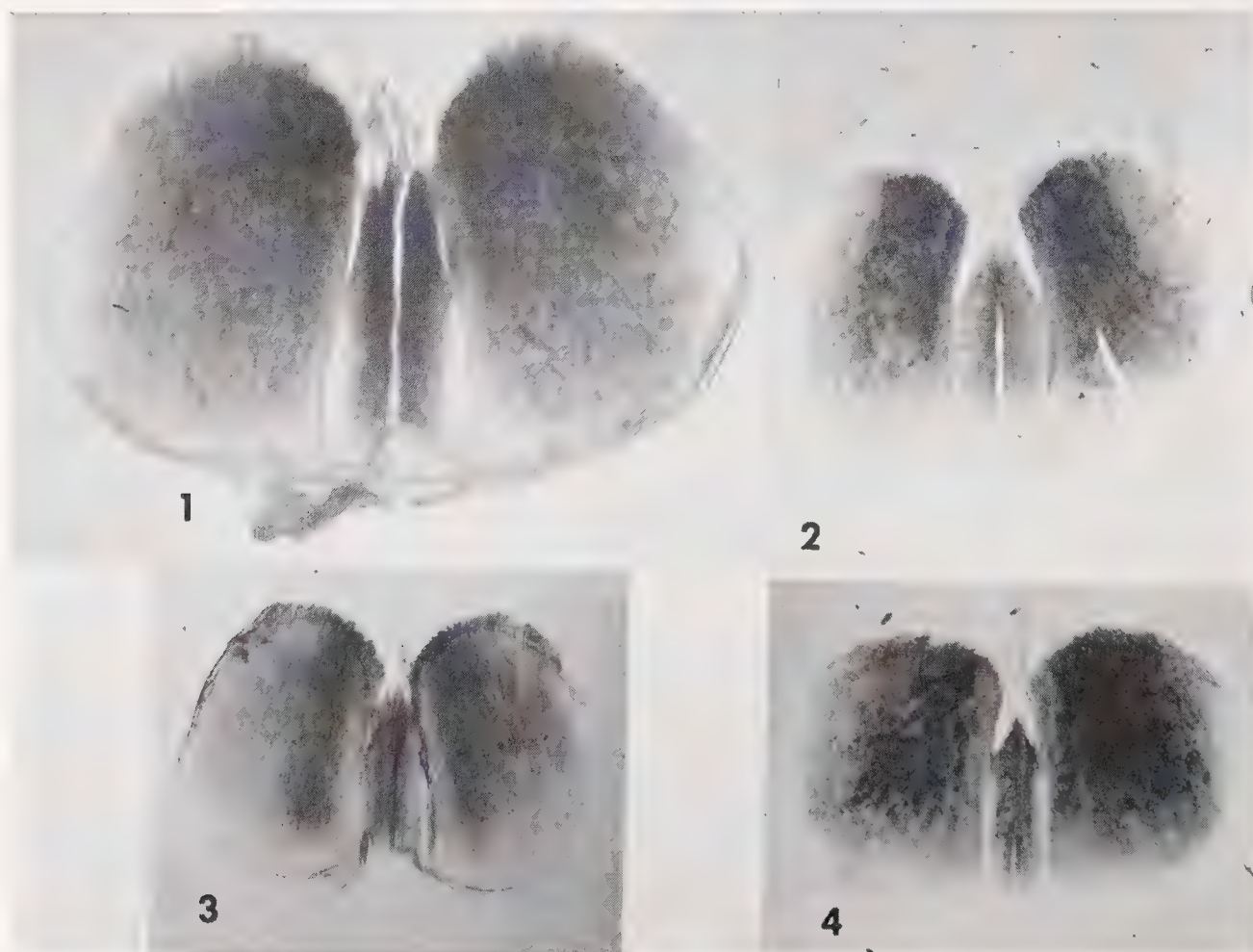


Plate 8. Jaws. Fig. 1. *Calliostoma zizyphinum* Linné, Millport Harbour, Scotland. Fig. 2. *C. jucundum* Gould, off Rio de la Plata, Argentina. Fig. 3. *C. occidentale* Mighels and Adams, Eastport, Maine. Fig. 4. *C. yucatecanum* Dall, off Port Isabel, Texas in 10½ fathoms (all about 25x).

It was attached at intervals to the glass of the aquarium and part of it was floating. Inside the ribbon were numerous, yellowish eggs irregularly arranged, each 0.25 mm. to 0.28 mm. when newly laid, covered by a thin membrane, and floating in a nutritive medium within the egg covering, and this was surrounded by a thick layer of jelly. A micropyle was present in the egg-covering of the unfertilized egg. According to Lebour "Fertilization is usually regarded as external, but the second specimen, taken from the tank and placed in a bowl whilst depositing its spawn continued to lay eggs which developed into crawling young." For the species of *Calliostoma* where the embryology is known, the trochophore and veliger stages are passed within the egg membrane. The veliger stage is reached in two days and at this stage the developing larva has a spiral shell of about $1\frac{1}{4}$ whorls, and a round velum in front of, and dorsal to, the foot (text fig. 1c). At the time of hatching the velum has disappeared; the tentacles, eyes, and two pairs of slender, branched, epipodial outgrowths are well-developed and the shell is about 0.32 mm. across. The shell is sculptured with rounded to elongate pits. Lebour stated the *zizyphinus* spawned in June at Plymouth, but Roberts (1902) stated that *Calliostoma papillosum* daCosta (= *granulatus* Born.) spawned all year round at Roscoff, France. The egg mass was similar to that of *zizyphinus*. He figures the newly hatched young of *conuloides*, showing four pairs of short, broad epipodial outgrowths.

Lebour has suggested that good characters for distinguishing the various genera of the Trochidae may be found in the type of egg mass laid, progressing from the genera *Mondonta* and *Gibbula* which produce eggs singly, to *Margarites* which lays the eggs in small shining lumps, to *Calliostoma* which produces its eggs in gelatinous ribbons, and *Cantharidus* which produces the eggs in gelatinous masses.

According to Shimer and Shrock (Index Fossils of North America, p. 480) the genus *Calliostoma* first appeared in the Upper Cretaceous and has a world distribution as fossils. In the Western Atlantic area several fossil species have been described mainly from Argentina (Oligocene to Pleistocene), Bowden, Jamaica (Miocene), Florida (Miocene and Pliocene), South Carolina and Virginia (Miocene). Many of the fossil species are remarkably similar to the recent species, differing but little in sculpture and shape.

ACKNOWLEDGMENTS

We are deeply indebted to many people for the loan or the gift of specimens used in this study. As with all previous numbers of *Johnsonia*, this one has benefited greatly because of the interest and cooperation of our many friends and we wish to thank the following for their kindness:

R. Tucker Abbott, Academy of Natural Sciences, Philadelphia; C. G. Aguayo, Museo Poey, Universidad de la Habana, Cuba; Frederick M. Bayer, United States National Museum; E. Binder, Muséum d'Histoire Naturelle, Genève, Switzerland; Harvey J. Bullis, Bureau of Commercial Fisheries, Pascagoula, Miss.; Alberto R. Carcelles, Cordoba, Argentina; Marion L. Chambers, Sarasota, Florida; Vincent Conde, Redpath Museum, Montreal, Canada; Bernard C. Cotton, South Australian Museum, Adelaide, South Australia; Marion W. Dewey, Paxton, Mass.; C. John Finlay, Varadero, Cuba; Mrs. W. C. Frisbey, Port Isabel, Texas; Harry and Kathleen Johnstone, Mobile, Alabama; Myra Keen, Stanford University, Stanford, California; George and Mary Kline, Madison, New Jersey; Hope Macpherson, National Museum of Victoria, Melbourne, Australia; Thomas L. McGinty, Boynton Beach, Florida; Donald F. McMichael, The

Australian Museum, Sydney, Australia; Arthur Merrill, United States Fisheries Laboratory, Woods Hole, Mass.; Donald Moore, Gulf Coast Research Laboratory, Ocean Springs, Miss.; Percy Morris, Peabody Museum, Yale University; Robert H. Parker, Scripps Inst. of Oceanography; Juan J. Parodiz, Carnegie Museum, Pittsburgh, Penn.; R. E. Petit, Ocean Drive Beach, South Carolina; Thomas Pulley, Houston Museum, Houston, Texas; Harald A. Rehder, United States National Museum; Emma B. Richardson, Charleston Museum, Charleston, South Carolina; Robert Robertson, Academy of Natural Sciences, Philadelphia; David and Nevada Schmidt, Sarona, Wisconsin; Jeanne S. Schwengel, Scarsdale, New York; Frederick Sibley, Boston, Mass.; Daniel and Barbara Steger, Tampa, Florida; Gordon Usticke, St. Croix, Virgin Islands; Gilbert Voss, Marine Laboratory, University of Miami, Miami, Florida; Germaine Warmke, Institute of Marine Biology, Mayagüez, Puerto Rico; J. A. Weber, Miami, Florida; Robert Work, Marine Laboratory, University of Miami, Miami, Florida.

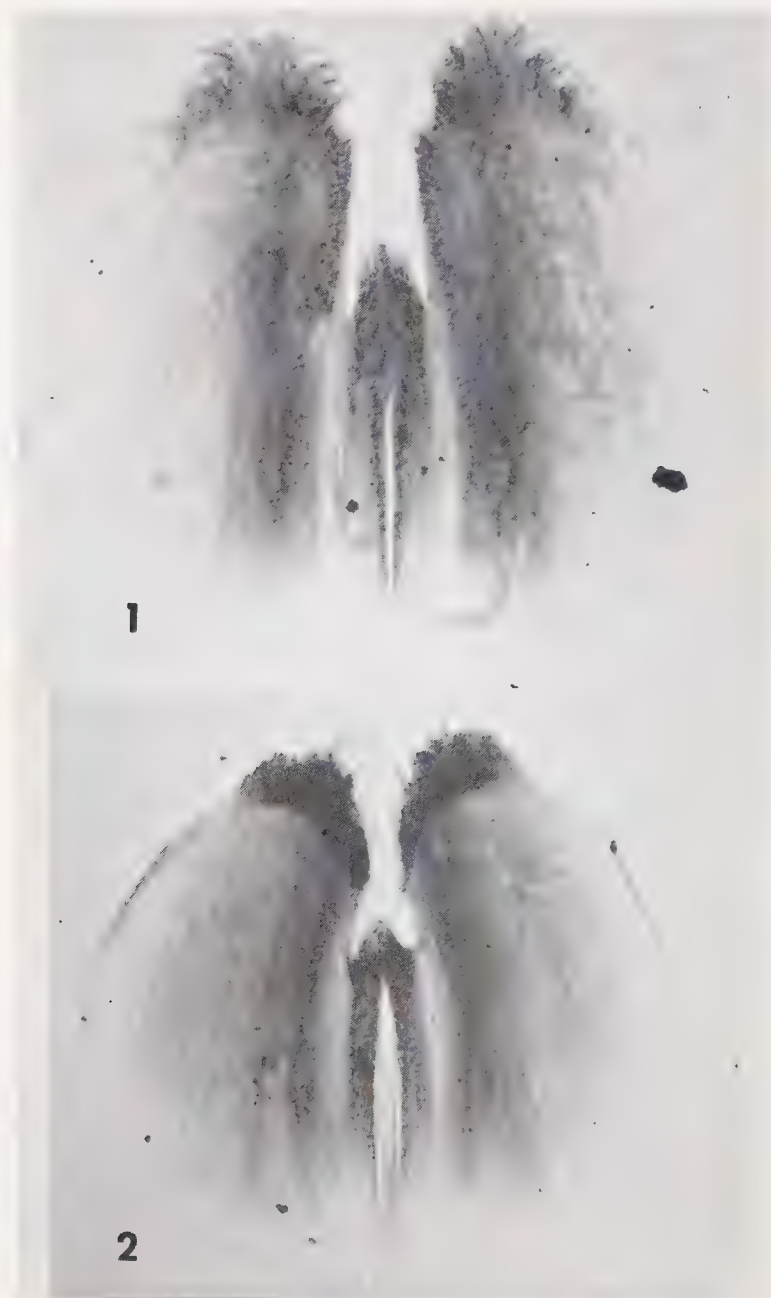


Plate 9. Jaws. Fig. 1. *Calliostoma jujubinum* Gmelin, Marco Island, Florida. Fig. 2. *C. bullisi* Clench and Turner, from the *Oregon*, station 2050, about 75 miles ESE of Cabo Orange, Amapá, Brasil (both about 25x).

ABBREVIATIONS

ANSP—Academy of Natural Sciences, Philadelphia
CM—Charleston Museum
MCZ—Museum of Comparative Zoology
SU—Stanford University
UMML—Univ. of Miami, Marine Laboratory
USFW—United States Fish and Wildlife Service
USNM—United States National Museum

Genus **Calliostoma** Swainson

Calliostoma Swainson 1840, Treatise on Malacology, p. 218 and p. 351 (type species, *Trochus zizyphinus* Linné, monotypic).

Conulus Nardo 1841, Atti Sci. Ital., p. 244 [we have not seen this publication].

Callisostoma 'Swainson' Sowerby 1842, Conchological Manual, 2nd edition, p. 90 [error for *Calliostoma* Swainson].

Zizyphinus Gray 1840, Synopsis of the Contents of the British Museum ed. 42, p. 147 [nomen nudum]; Gray 1843 [in] Dieffenbach, Travels in New Zealand 2: 237.

Callistomus Herrmannsen 1846, Indicis Generum Malacozoorum 1: 155.

Zizyphinus 'Gray' Souverbie 1875, Journal de Conchyliologie 23: 40.

Zizyphimus 'Gray' Crosse 1876, Journal de Conchyliologie 24: 118.

Manotrochus Fischer 1885, Manuel de Conchyliologie, Paris, p. 827 (type species, *Trochus unidentatus* Phil., monotypic).

Jacinthinus Monterosato 1889, Bull. Soc. Malacologica Italiana 14: 79 (type species, *Zizyphinus conulus* Linné, monotypic).

Ampullotrochus Monterosato 1890, Naturalista Siciliano 9: 145 (type species, *Trochus granulatus* Born, original designation).

Callistoma 'Swainson' Cossmann 1918, Essais Paleoconchologie Comparée, Paris, 11: 286.

Dymares Schwengel 1942, Notulae Naturae, no. 106, p. 1 (type species, *Calliostoma agalma* Schwengel, original designation).

Type species, *Trochus zizyphinus* Linné, monotypic.

The shells are trochoid in shape and sculptured generally with spiral, beaded cords. The aperture is subquadrate, the columella usually arched and frequently truncate at the base. Both umbilicate and imperforate species occur. The coloration varies among the many species but when present it usually appears as a dull yellow or brown ground color with axial flames of red or red-brown as a secondary coloration. The interior of the aperture is highly iridescent in most if not all species.

Remarks. On page 218 where Swainson first introduced the name *Calliostoma* he stated: "The *Trochus zizyphinus* of British writers will give a very good idea of these shells." This is the only name he associates with *Calliostoma* on this page. On page 351 he lists eight species under this genus and places *zizyphinus* first. Gray in 1847 gives *zizyphinus* as the type species. Herrmannsen 1846 was in error in using *T. conulus* Linné as the type species.

Subgenus **Calliostoma** Swainson

Shells generally imperforate, marked with axial flames of reddish brown or unicolored. Sculptured with beaded cords, occasional species are found having these cords beaded only on the early whorls. Aperture subquadrate.

Radula with a denticulate central tooth, five rather uniform lateral teeth, the first marginal tooth broad, the succeeding marginals becoming more attenuate, and having numerous, fine denticles (see Plates 3 and 4).

Jaws subcircular with their anterior ends broadly rounded and with a short fringe (see Plate 8).



Plate 10. Jaws. Fig. 1. *Calliostoma bairdii* Verrill and Smith, south side of Little Georges Bank, Massachusetts in 77 fathoms. Fig. 2. *C. rosewateri* Clench and Turner, from the *Oregon*, station 1989, about 90 miles SE of Galeota Point, Trinidad (both about 25x).

***Calliostoma (Calliostoma) zizyphinum* Linné**

Plate 1; Plate 3, fig. 1; Plate 8, fig. 1; Plate 12

Trochus zizyphinus Linné 1758, *Systema Naturae*, ed. 10, p. 759 (M. Mediterraneo & Europaeo).

Trochus discrepans Brown 1818, *Mem. Wernerian Nat. Hist. Soc.* 2: 501, pl. 24, fig. 4 (Holywood, Belfast Lough, Ireland).

Trochus conuloides Lamarck 1843, *Animaux sans Vertèbres* (2) 9: 142 (l'Océan européen et la Méditerranée).

Ziziphinus vulgaris Gray 1850, *Figures of Molluscous Animals* 4: 89, pl. 43, fig. 3 [refers to *S. della Chiage* in Poli 1826, 3: pl. 52, figs. 3 and 5].

Trochus zizyphinus Linné. Hanley 1855, *Ipsa Linnaei Conchylia*, London, p. 322.

Description. Shell reaching 35 mm. (about $1\frac{3}{8}$ inches) in length, trochoid, solid in structure, rather finely sculptured and imperforate. Color a light reddish brown with axial flames of red at the whorl periphery. Whorls 10, flat sided and with a rounded carina at the periphery. Base of shell slightly convex. Spire extended and produced at an angle of 65° to 70° . Aperture subquadrate, the outer lip simple and produced at an angle of 45° from the base. Columella thickened, arched and truncate. Suture slightly indented. Sculpture of the first 5 postembryonic whorls beaded, the remaining whorls with flattened cords. The base of the shell nearly smooth or with flattened cords. Operculum circular, multispiral and corneous. Nuclear whorl $1\frac{1}{4}$, minute, brownish and smooth.

length	width	
35 mm.	33 mm.	Cannes, France
23	21	Millport Harbour, Scotland
23.5	23.5	Pino, Corsica
21.5	23	Swanage, England

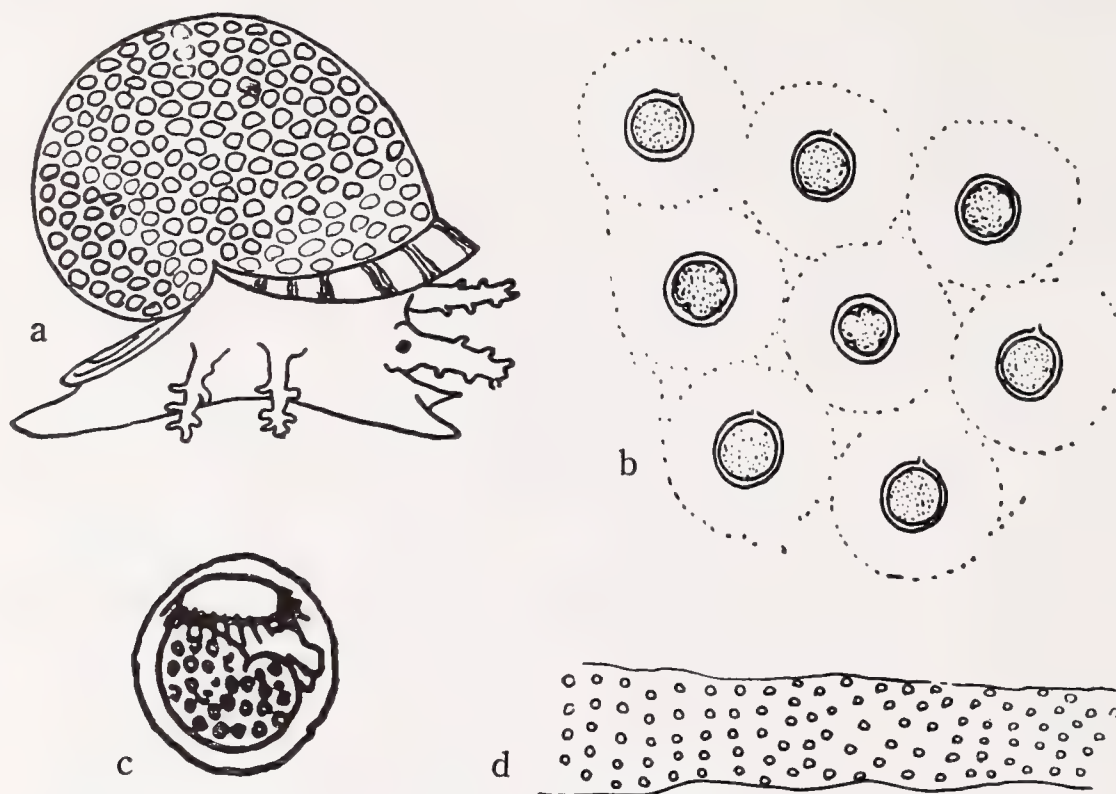
Types. In 1855 Hanley reported that the original specimens of Linné were in the Linnean Society, London. These specimens are still in their possession to judge by the photographs made of this collection a few years ago. The type figure, here selected, is that of Martin Lister, *Historiae Animalium Angliae*, London, 1678, p. 116, pl. 3. fig. 14. This reference was given among others by Linné.

Remarks. This species would appear to be related to *C. conulum* Linné, differing in being more coarsely sculptured and also somewhat in its proportions. Based upon shell



Plate 11. Jaws. Fig. 1. *Calliostoma schroederi* Clench and Aguayo, from the *Combat*, station 235, off Matanilla Shoals, Little Bahama Bank, Bahama Islands. Fig. 2. *C. hendersoni* Dall, from the *Oregon*, station 1349, off Cay Sal Bank, Bahama Islands (both about 25x).

characters, *C. zizyphinum* Linné does not appear to be closely related to any species other than *C. marionae* in the Western Atlantic. The jaws and radula, however, are quite different.



Text fig. 1. Eggs and young of *Calliostoma zizyphinum* Linné. a. Young at the time of hatching. b. Eggs greatly enlarged showing the egg membrane and the thick gelatinous layer which surrounds each egg. c. Veliger larva. d. Section of the egg ribbon. (All from Lebour.)

The following is from J. G. Jeffreys 1865, *British Conchology* 3: 332. "The spelling of the specific name has partaken of the variability of the objects designated. *Zezyphinus*, *zyziphinus* and *sisyphinus* are the readings proposed by Chemnitz, Born, Montagu and Macgillivray. The last of these writers imagined that the name was derived from the rolling stone of Sisyphus and not from *zizyphum*, the fruit of the jujube-tree."

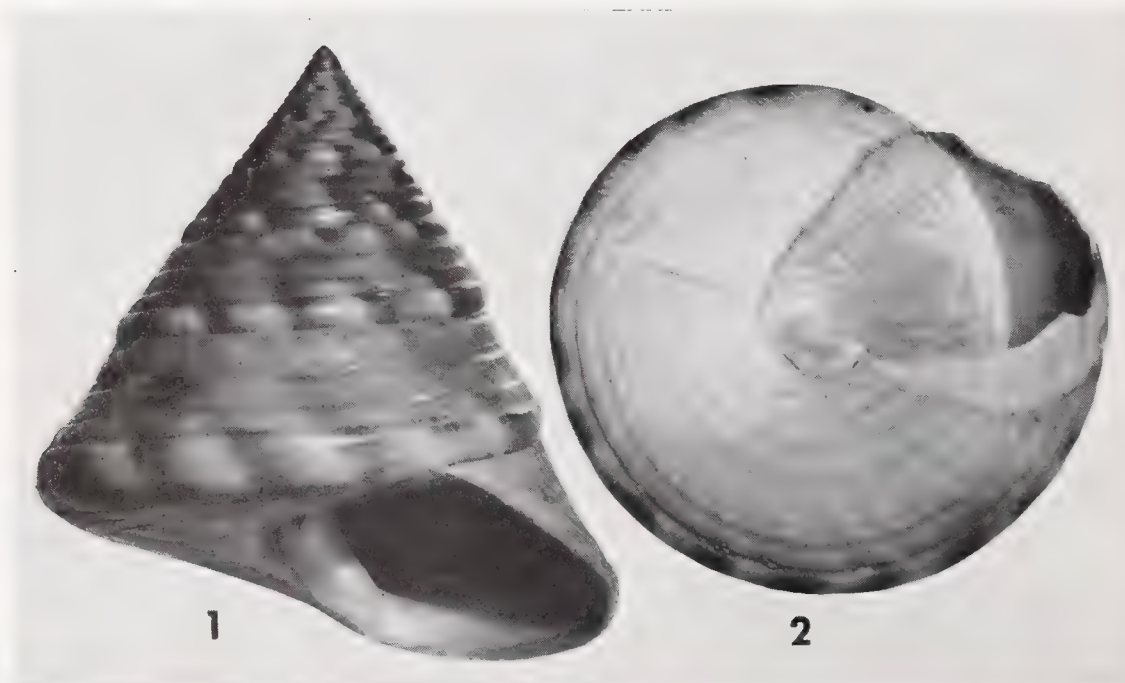


Plate 12. Figs. 1-2. *Calliostoma zizyphinum* Linné, Millport Harbour, Scotland (about 2.9x).

Names for several varieties have been proposed but they appear to have little or no value as their designation applies to minor morphological or color differences.

Specimens examined. GREAT BRITAIN: Aberdeen Bay; Oban; Millport Harbour (all Scotland). Grimsby; Hastings; Swanage; Weymouth; Torquay; Scilly Isles; Guernsey, Channel Islands (all England, all MCZ). FRANCE: Cherbourg and St. Vaast, Manche; St. Servan, St. Lunaire and St. Malo, Ile et Vilaine; Bréhec, Cotes du Nord; Cannes, Alpes Maritimes (all MCZ). PORTUGAL: Lisboa (MCZ). JUGOSLAVIA: Dalmatia (MCZ). MEDITERRANEAN ISLANDS: Pino, Corsica (MCZ). TUNIS: Gulf of Gabes (MCZ).

Calliostoma (Calliostoma) occidentale *Mighels and Adams*

Plate 4, fig. 2; Plate 8, fig. 3; Plate 13

Trochus occidentalis Mighels and Adams 1842, Boston Journal of Nat. Hist. **4**: 47–48, pl. 4, fig. 16 (Casco Bay, Maine from stomach of a haddock); Clench and Turner 1950, Occasional Papers on Mollusks **1**: 319, pl. 40, fig. 13.

Trochus quadricinctus Wood 1842, Annals and Magazine of Nat. Hist. **9**: 531 [nomen nudum]; Wood 1848, The Crag Mollusca (Palaeontographical Society, London) **1**: 125, pl. 13, figs. 2a–b (Coralline and Red Crag of Sutton, England [in the synonymy of *Trochus formosus* McAndrew and Forbes]).

Margarita alabastrum 'Beck' Lovén 1846, Ofversigt K. Vet. Acad. Föhr. **3**: 152 (Bergen-Finm. [Norway]).

Trochus formosus McAndrew and Forbes 1847, Annals and Magazine of Nat. Hist. **19**: 96, pl. 9, fig. 1 (Seas around the Zetland [Shetland] Islands, Scotland).

Trochus alabastrum 'Beck' Philippi 1849 [in] Martini and Chemnitz, Conchilien Cabinet (2) **2**: pt. 3, p. 91, pl. 15, fig. 14 (Norwegische Meer von Bergen bis Finnmarken); Forbes and Hanley 1853, History of British Mollusca **2**: 497, pl. 66, figs. 7–8.

Description. Shell reaching 16.5 mm. ($\frac{5}{8}$ of an inch) in length, top shaped, imperforate, rather thin but strong and highly sculptured. Color yellowish ivory when covered with thin periostracum. Where the periostracum is very thin or worn away the shell is highly opalescent. Whorls 8 and convex. Spire moderately extended, the angle variable, being produced at an angle of between 70° to 80° . Aperture subcircular, the outer lip simple and produced at an angle of about 45° from the base. Columella iridescent, short and arched. Suture slightly indented and defined mainly by the wider space between the spiral cords. Sculpture consisting of 3 to 5 strong spiral cords above the whorl periphery. Below the periphery there may be 9 to 12 somewhat weaker cords which vary in width and height. On the first 3 to 4 whorls the cords are all finely beaded; on the later whorls the beading is indefinite and restricted to the uppermost cord. Embryonic whorls $1\frac{1}{2}$, minute, smooth and opaque white. Operculum thin, corneous, circular, with a central nucleus and multispiral coiling. Periostracum thin, light yellowish ivory and occasionally deciduous.

height	width	
10 mm.	9 mm.	lectotype
16	16	off Georges Bank, Mass.
14	12.5	off Eastport, Maine
16	14.5	off Isle of Shoals, New Hampshire

Types. The lectotype of *Trochus occidentalis* Mighels and Adams, here selected, is in the Museum of Comparative Zoology, no. 156007, from Casco Bay, Maine. This specimen, received from Mighels, was originally in the C. B. Adams collection which is now

in this museum. This has been selected as the lectotype because the collection of J. W. Mighels in the museum of the Portland Society of Natural History, Portland, Maine, was destroyed by fire in 1853 (Johnson 1949, p. 214).

Remarks. This species appears to be most closely related to *Calliostoma ligatum* Gould (= *costatum* Martyn) of the west coast of North America. It differs by being smaller, much lighter in structure, and having a much thinner and translucent periostracum. In addition, the cords on the early whorls of the west coast species are not beaded, and this species also lacks the highly iridescent surface of *C. occidentale*.

In England, *C. occidentale formosum* was reported in the Pliocene (Crag mollusca) by S. V. Wood.

The range in depth of this species is rather extensive, (6 to 980 fathoms). The depth of 980 fathoms was based on a specimen collected alive by the *Blake* in 1877.

As far as we can trace, nothing is known of the biology of this species. They are apparently plant and detritus feeders.

Range. EASTERN ATLANTIC: Finmarks, Norway south to Bergen and south to northern Scotland, including the Shetland and Orkney Islands.

WESTERN ATLANTIC: From off Nova Scotia and south on the Banks off Massachusetts, continuing in deeper water on the continental slope south to the latitude of Barnegat Bay, New Jersey.

Specimens examined. WESTERN ATLANTIC: NOVA SCOTIA: off Sable Island in 55 fathoms (MCZ); *Speedwell*, station 103, about 70 miles E of Liverpool (44°02' N; 63°20' W) in 92 fathoms (USNM); Emerald Bank in 45 fathoms; about 40 miles SW of Cape Sable in 76 fathoms; off Digby (all MCZ). NEW BRUNSWICK: St. Andrews (F. Sibley); Grand Harbor, Grand Manan (MCZ; USNM). MAINE: off Campobello Island, Eastport in 10 fathoms (USNM); off Eastport in 20 fathoms (Yale Univ.); Perry in 6 fathoms (MCZ); off Little River Head, Machias in 40 fathoms (USNM); Casco Bay (MCZ); *Bache*, station 6, about 68 miles E of Portland (43°38' N; 69°01' W) in 82 fathoms (USNM). NEW HAMPSHIRE: 250 miles E of Portsmouth (42°58' N; 65°57' W) in 250 fathoms (USFW); off Isle of Shoals; Jeffreys Ledge in 70 fathoms (both MCZ). MASSACHUSETTS: *Bache*, station 52, Cashe Ledge, about 112 miles E of Newburyport (42°51' N; 68°52' W) in 27 fathoms; *Bache*, station 29, about 23 miles E of Newburyport (42°47' N; 70°20' W) in 33 fathoms; *Speedwell*, station 39, Brown's Bank, about 240 miles E of Newburyport (42°44' N; 66°27' W) in 75 fathoms; *Albatross*, station 2520, about 330 miles E of Newburyport (42°41' N; 64°55' W) in 62 fathoms (all Yale Univ.); off Ipswich Bay in 13 fathoms; off Thatchers Island in 45 fathoms (both MCZ); *Speedwell*, station 124, about 22 miles SE of Gloucester (42°32' N; 70°22' W) in 51 fathoms (USNM); Stellwagen Bank, off Boston in 35 fathoms; *Albatross II*, station 21159, about 200 miles E of Provincetown (42°16' N; 66°34' W) in 160 fathoms; Georges Bank (42°04' N; 60°00' W) in 55 fathoms (all MCZ); Cultivator Shoals, about 95 miles E of Chatham (41°44' N; 68°15' W) in 21 fathoms (USFW); *Albatross*, station 2526, about 205 miles E of Chatham (41°40' N; 65°46' W) in 121 fathoms (Yale Univ.); *Blake*, station 307, off Georges Bank (41°29' N; 65°47' W) in 980 fathoms (MCZ); *Albatross*, station 2580, about 57 miles E of Nantucket Island (41°25' N); 69°

01' W) in 83 fathoms (USNM). NEW JERSEY: *Blake*, station 310, about 200 miles E of Barnegat Bay (39°59' N; 70°18' W) in 260 fathoms (MCZ); *Fish Hawk*, station 945, about 210 miles E of Barnegat Bay (39°58' N; 71°13' W) in 207 fathoms; *Fish Hawk*, station 894, about 170 miles E of Barnegat Bay (39°53' N; 70°58' W) in 365 fathoms (both USNM).

EASTERN ATLANTIC: NORWAY: Finnmarks (USNM); Tromsö (MCZ).



Plate 13. *Calliostoma occidentale* Mighels and Adams. Figs. 1-2. *Blake*, station 302, off Georges Bank, Massachusetts in 73 fathoms. Fig. 3. Casco Bay, Maine. Lectotype (all about 4.6x).

***Calliostoma (Calliostoma) pulchrum* C. B. Adams**

Plate 3, fig. 3; Plate 14

Trochus pulcher C. B. Adams 1850, Contributions to Conchology, no. 5, p. 69 (Jamaica); Clench and Turner 1950, Occasional Papers On Mollusks 1: 331, pl. 40, fig. 7.

Calliostoma veliei Pilsbry 1900, Nautilus 13: 128 (Caxambas Pass, S. W. Florida).

Description. Shell reaching 14.5 mm. (about $\frac{1}{2}$ inch) in length, trochoid, imperforate, rather thin in structure and finely sculptured. Color a mottled ivory-white and light yellowish brown with small brownish red spots more or less evenly dispersed on beaded spiral cords. In addition, there may be similar spots of white, particularly on the peripheral cords. Whorls 8 to 10, flat sided and with a sharply angulated keel. Spire extended and produced at an angle of about 55°. Aperture subquadrate, the outer lip simple and produced at an angle of about 45° from the base. Columella white, arched inwardly and thickened to form a ridge which is subtruncate at the base. Suture generally indistinct but defined by the larger beaded cords which mark the periphery of the whorl above. In some specimens the succeeding whorl is slightly inset so that the beaded cords overhang. Sculpture consisting of numerous and rather finely beaded cords, those on the periphery

being slightly larger and more coarsely beaded. There are from 4 to 10 finer, beaded cords above the periphery. On the base of the shell the cords are very fine, numerous and variable in number. Four to six of these cords are spotted with reddish dots. These spotted cords are more or less evenly distributed. Operculum thin, corneous, circular, with a central nucleus and multispiral coiling.

Jaws and radula similar to those figured for *C. jucundum* (see Plate 8, fig. 2).

length	width	
9 mm.	6 mm.	Holotype of <i>C. pulchrum</i> C. B. Adams
12	10.5	Paratype of <i>C. veliei</i> Pils.
13.5	11.5	off Cayo Muerto, Bahía Honda, Cuba in 3 fathoms
10	11	Holotype of <i>veliei</i> Pils.

Types. The holotype of *Calliostoma pulchrum* C. B. Adams is in the Museum of Comparative Zoology, no. 156356, from Jamaica. The holotype of *C. veliei* Pilsbry from Caxambas Pass, Florida is in the Academy of Natural Sciences, Philadelphia, no. 77893. A paratype is in the Museum of Comparative Zoology, no. 140372.

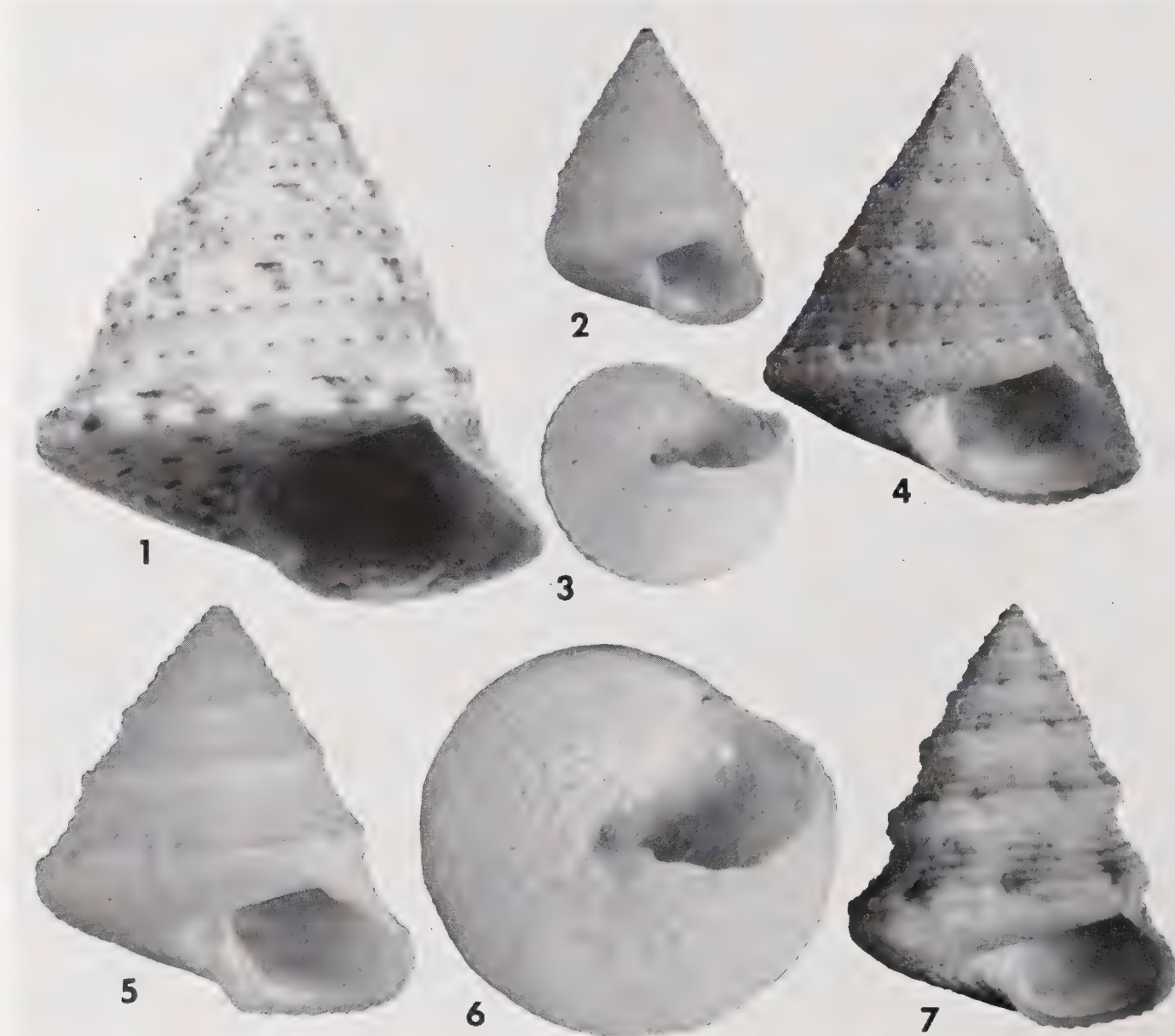


Plate 14. *Calliostoma pulchrum* C.B.Adams. Fig. 1. Nassau, New Providence, Bahama Islands (about 5.4x). Fig. 2. Jamaica. Holotype (4x). Fig. 3. Basal view, Marco, Florida (4x). Fig. 4. Off Cayo Muerto, Bahía Honda, Pinar del Rio, Cuba (4x). Fig. 5. Holotype of *C. veliei* Pilsbry [= *C. pulchrum* C.B.Ad.], Caxambas Pass, Florida (about 4.6x). Fig. 6. Paratype of *C. veliei* Pilsbry (4.6x). Fig. 7. Marco, Florida (4x).

Remarks. See under *C. roseolum* Dall and *jucundum* Gould. This species occurs in the littoral zone and to depths of about 80 fathoms.

Range. North Carolina, Florida, Gulf of Mexico and south to the Caribbean.

Specimens examined. NORTH CAROLINA: *Albatross*, station 2596, about 17 miles SE of Cape Hatteras (35°08' N; 75°10' W) in 49 fathoms (USNM). FLORIDA: Palm Beach (J. Schwengel); Lake Worth, Boynton (T. McGinty); off Cape Florida, Key Biscayne in 8 fathoms (MCZ); *Eolis*, station 147, off Fowey Light, Biscayne Bay in 35 fathoms; *Eolis*, station 173, off Fowey Light, Biscayne Bay in 58 fathoms; *Eolis*, station 136, off Long Reef, off Elliot Key in 58 fathoms; *Eolis*, station 350, off Triumph Reef, off Elliot Key in 70 to 90 fathoms (all USNM); Turtle Harbor, Key Largo in 6 fathoms (USNM); off Sombrero Light, Key Vaca in 20 fathoms; off Looe Key, Big Pine Key in 29 fathoms (both MCZ); *Eolis*, station 196, off Sambo Reef in 58 fathoms; *Eolis*, station 160, off Sand Key in 62 fathoms; Key West in 40 fathoms (all USNM); Wash-erwoman Shoal, Key West in 3 fathoms (J. S. Schwengel); off Fort Walton in 13 to 19 fathoms (MCZ); off Destin in 20 fathoms (T. McGinty); off Panama City in 84 fathoms (D. Moore); *Albatross*, station 2405, about 60 miles S of Cape San Blas (28°45' N; 85°02' W) in 30 fathoms; *Albatross*, station 2406, about 70 miles SE of Cape San Blas (28°46' N; 84°49' W) in 26 fathoms (both USNM); Cedar Keys (UMML); off Anclote Key, Pasco Co. in 12½ fathoms (USNM); off Johns Pass, St. Petersburg in 27 fathoms (J. Schwengel); off Egmont Key in 14 fathoms (T. McGinty); Sanibel Island in 4 to 7 fathoms (J. Schwengel; T. McGinty); Marco Island (D. and N. Schmidt; USNM); Caxambas Pass (MCZ). MISSISSIPPI: off Mississippi Delta in 40 fathoms (ANSP). LOUISIANA: *Oregon*, station 297, about 100 miles south of Morgan City (28°05' N; 91°00' W) in 51 fathoms. MEXICO: Campeche Bank, 170 miles NE of Progreso, Yucatan in 30 fathoms (T. McGinty); off Alacran Reef, Yucatan in 65 fathoms (D. Steger); off Cabo Catoche, Yucatan in 18 fathoms (USNM). BAHAMA ISLANDS: Parrot Cays and Cooper Jacks Cay, Great Abaco (R. Robertson); Moraine Cay, Little Abaco (USNM); Nassau, New Providence (USNM; ANSP; T. McGinty); Dicks Point, Nassau, New Providence (MCZ); South Beach, New Providence (MCZ); North Bimini Island (USNM; Robert Robertson); 4 miles E of Arthurs Town, Cat Island (MCZ); Black Point, Great Guana Cay, Exuma Group (G. and M. Kline). CUBA: Cape San Antonio, Pinar del Río; Punta Cajón, Pinar del Río; La Esperanza, Pinar del Río (all USNM); Bahía Honda, Pinar del Río in 1 to 12 fathoms (USNM; T. McGinty); Cayo Muerto, Bahía Honda, Pinar del Río (C. G. Aguayo); La Chorrera, Habana (MCZ); Matanzas, Matanzas (D. Steger); Bahía de Cárdenas, Matanzas (ANSP; T. McGinty; J. A. Weber); off Punta de Hicacos in 11 fathoms and off Cayo Blanco in 15 fathoms, Cardenas; off Cayo Galindo in 5 fathoms; off Cayo Mono Grande in 5 fathoms, all Matanzas (all V. Condé); Cayo Santa Maria, off Punta Alegre, Camagüey (R. Humes). JAMAICA: (MCZ). VIRGIN ISLANDS: Altana Bay and Frederiksted, St. Croix (G. Usticke); St. Thomas (USNM). CARIBBEAN ISLANDS: off Old Providence Island (USNM).

***Calliostoma (Calliostoma) roseolum* Dall**

Plate 4, fig. 3; Plate 15

Calliostoma roseolum Dall 1880, Bulletin Museum of Comparative Zoology 9: 45 (*Blake*, station 11, off Habana, Cuba, 24°43' N; 83°25' W, in 37 fathoms); Dall 1889, Bulletin Museum of Comparative Zoology 18:

366, pl. 24, figs. 6-6a; not *C. roseolum* Guppy and Dall 1896, Proc. United States Nat. Mus. **19**: 324.

Calliostoma apicinum Dall 1881, Bulletin Museum of Comparative Zoology **9**: 46; Dall 1889, Bulletin Museum Comparative Zoology **18**: 366, pl. 24, figs. 3-3a (Blake, station number not given, off Barbados in 100 fathoms).



Plate 15. *Calliostoma roseolum* Dall. Fig. 1. Blake (no station number) off Barbados in 100 fathoms. Holotype of *C. apicinum* Dall [= *C. roseolum* Dall]. Fig. 2. Paratype from the same locality (both 10.7x). Fig. 3. Blake, station 11, off Habana, Cuba in 37 fathoms. Holotype of *C. roseolum* Dall (about 5.5x).

Description. Shell reaching 13.7 mm. (about $\frac{1}{2}$ inch) in length, trochoid, imperforate, or occasionally slightly rimate in the young, rather strong in structure and finely sculptured. Color ivory, mottled with patches of yellowish brown. Whorls 9 to $9\frac{1}{2}$. Early whorls strongly convex and often somewhat keeled. Succeeding whorls often slightly inset below the periphery of the preceding whorl giving a stepped appearance. Spire extended and produced at an angle of about 50° . Aperture subquadrate, outer lip simple and produced at an angle of about 40° from the base. Columella white, slightly twisted and truncate. Suture indistinct, indicated mainly by the inset of the whorls. Sculpture consisting of numerous and rather coarsely beaded cords with the peripheral cord being somewhat large and more coarsely beaded. Larger beaded cords may alternate with smaller ones above the periphery but below they are all uniform. Embryonic whorls very small, white and smooth. Operculum thin, corneous, dark brown in color and multispiral.

length	width	
9.4 mm.	6.8 mm.	Holotype of <i>roseolum</i> Dall
12	8	off Cape Hatteras, North Carolina
12.5	8.4	off Tortugas, Florida
13.7	8.2	off Hillsboro, Florida
12	8.5	off Sanibel Island, Florida
7.5	5.8	Holotype of <i>apicinum</i> Dall

Types. The holotype of *Calliostoma roseolum* Dall from the *Blake*, station 11, off Habana, Cuba ($24^{\circ}43' N$; $83^{\circ}25' W$) in 37 fathoms is in the Museum of Comparative Zoology, no. 7563. The holotype of *C. apicinum* Dall is in the United States National Museum, no. 95013 from the *Blake* (station number not given), off Barbados in 100 fathoms. Paratypes from the same station and from the *Blake*, station 56, off Habana, Cuba in 175 fathoms are in the Museum of Comparative Zoology, no. 7564 and no. 7565.

Remarks. This species is fairly close in its relationship to *C. pulchrum* C. B. Adams. It differs in being more attenuate and in having the cords on the base larger and more strongly beaded. In general, there is less coloration in *roseolum* than in *pulchrum*.

C. apicinum Dall appears to be only a young specimen of *roseolum*. In young specimens, the whorls are more flat sided, the keel sharper, and sometimes young specimens may be rimately perforate. As the animal matures the whorls become more convex. In 1872, William Stimpson, dredging with the *Bache* some 40 miles off Sanibel Island, Florida, obtained a fine growth series of *roseolum* Dall. This series shows the young with the whorls flat sided and the gradual change to the adult where the whorls are rounded. *C. roseolum* ranges in depth from 7 to 175 fathoms.

Range. North Carolina, Florida and Mexico, and south to the Barbados.

Specimens examined. NORTH CAROLINA: *Albatross*, station 2596, 19 miles SE of Cape Hatteras ($35^{\circ}08' N$; $75^{\circ}10' W$) in 49 fathoms (USNM). FLORIDA: *Triton*, station 800, off Palm Beach Inlet in 25 fathoms; off Lake Worth in 60 fathoms (both T. McGinty); off Lantana in about 66 fathoms (J. S. Schwengel); off Boynton Beach in 10 fathoms; off Delray Water Tank in 80 fathoms; off Hillsborough Inlet in 80 fathoms (all MCZ); *Eolis*, station 312, off Government Cut, Miami in 25 fathoms (USNM); south of Government Cut, Miami in 27 fathoms (T. McGinty); *Eolis*, station 68, off Miami in 45 fathoms; *Eolis*, station 76, off Fowey Light in 40 fathoms; *Eolis*, station 80, off Fowey Light in 38 fathoms (all USNM); 5 miles SSE of Carysfort Light, Key Largo in 75–83 fathoms; 3 miles E of Molasses Reef, Key Largo in 33–66 fathoms; $3\frac{1}{2}$ miles E of The Elbow, Key Largo in 21 fathoms (all MCZ); 2 miles off Conch Reef, Plantation Key in 35 fathoms (USNM); 6 miles SE of Sombrero Light, off Marathon in 66 fathoms (MCZ); *Albatross*, station 2414, about 70 miles NW of Key West ($25^{\circ}04' N$; $82^{\circ}59' W$) in 26 fathoms; *Albatross*, station 2317, about 7 miles SW of Key West ($24^{\circ}25' N$; $81^{\circ}46' W$) in 45 fathoms (both USNM); *Oregon*, station 1021, off Tortugas ($24^{\circ}54' N$; $83^{\circ}25' W$) in 38 fathoms (H. Bullis); *Blake*, station 12, off Tortugas ($24^{\circ}43' N$; $83^{\circ}16' W$) in 36 fathoms (MCZ); SW of Tortugas in 35 fathoms (USNM); off Sanibel Island in 7 fathoms (J. S. Schwengel); *Bache*, station 55S, about 40 miles off Sanibel Island ($26^{\circ}16' N$; $82^{\circ}45' W$) in 16 fathoms; off Captiva Island in 27 fathoms (both USNM); SW of Egmont Key in 70 fathoms (D. Steger); *Oregon*, station 937, 90 miles W of Egmont Key, Tampa Bay ($27^{\circ}30' N$; $84^{\circ}14' W$) in 38 fathoms; *Oregon*, station 935, about 51 miles W of Egmont Key, Tampa Bay ($27^{\circ}36' N$; $83^{\circ}40' W$) in 27 fathoms (both H. Bullis); WSW of John's Pass, Pinellas Co. (D. Steger); *Albatross*, station 2407, about 71 miles SE of Cape San Blas ($28^{\circ}47' N$; $84^{\circ}37' W$) in 24 fathoms; *Albatross*, station 2370, about 30 miles SW of Cape San Blas ($29^{\circ}18' N$; $85^{\circ}32' W$) in 25 fathoms; *Pelican*, station 137-2, about 63 miles SSW of Pensacola ($29^{\circ}36' N$;

87°29' W) in 35 fathoms (all USNM); off Panama City in 21 fathoms; off Pensacola in 35 fathoms (both T. McGinty). ALABAMA: *Albatross*, station 2390, about 58 miles S of Mobile Bay (29°27' N; 87°48' W) in 30 fathoms (USNM); *Oregon*, station 634, about 65 miles S of Mobile (29°33' N; 87°58' W) in 21 fathoms (H. Bullis). LOUISIANA: *Oregon*, station 303, about 100 miles S of Vermillion Bay (27°57' N; 92°02' W) in 48 fathoms (H. Bullis). MEXICO: off Campeche Banks in 30 fathoms (T. McGinty; W.C. Frisbey); *Albatross*, station 2363, about 30 miles N of Cabo Catoche, Yucatan (22°07' N; 87°06' W) in 21 fathoms (USNM); 135 miles ENE of Alacran Reef, Campeche Bank, Yucatan in 65 fathoms (ANSP). CUBA: *Blake*, station 56, off Habana (23°09' N; 82°21' W) in 175 fathoms (MCZ). LESSER ANTILLES: *Blake*, station 290, off Barbados (13°11' N; 59°38' W) in 73 fathoms (USNM); *Blake* (station number not given), off Barbados in 100 fathoms (USNM; MCZ).

Calliostoma (Calliostoma) fascinans Schwengel and McGinty

Plate 16

Calliostoma fascinans Schwengel and McGinty 1942, Nautilus 56: 15, pl. 6, fig. 2 (dredged off Lake Worth, Florida in about 400 feet).

Description. Shell reaching 10.5 mm. (about $\frac{1}{2}$ inch) in length, trochoid, imperforate, moderately strong in structure and coarsely sculptured. Color ivory-white and mottled with faint reddish brown. Whorls 9, flat sided and sharply keeled. Spire extended and produced at an angle of 50°. Aperture subquadrate, outer lip simple and produced at an angle of about 60° from the base. Columella white, slightly arched and truncated. Suture indistinct. Sculpture consisting of numerous and rather coarsely beaded cords, the peripheral cord being the largest and most coarsely beaded. There are 4 to 6 beaded cords above the periphery and 7 to 8 finely beaded cords on the flattened base. Beads on succeeding cords aligned axially and connected by a slight axial ridge giving the shell a reticulate appearance. Nuclear whorls small, white and smooth. Operculum circular, multispiral and corneous.

Jaws broadly rounded anteriorly, with large scales and a narrow fringe on the anterior margins, closely resembling those illustrated on Plate 8. Radula similar to that of *roseo-*

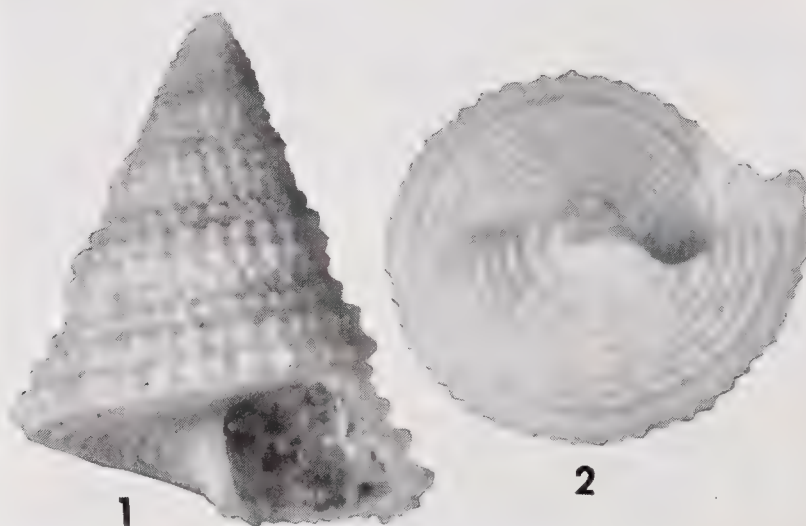


Plate 16. *Calliostoma fascinans* Schwengel and McGinty. Off Lake Worth, Florida. Fig. 1. Holotype. Fig. 2. Paratype (both 8x).

lum differing mainly in that the first marginal tooth is proportionately larger with a heavier base and only five denticles.

length	width	
7 mm.	5.8 mm.	Holotype
10.5	8.5	ENE of Alacran Reef, Yucatan, Mexico

Types. The holotype of *C. fascinans* Schwengel and McGinty is in the Academy of Natural Sciences Philadelphia, no. 178785, not 178634 as published. The type locality is from off Lake Worth, Florida in about 400 ft. [66 fathoms], T. L. McGinty, collector. Paratypes from the same locality are in the Museum of Comparative Zoology, no. 207074.

Remarks. This species is most closely related to *C. roseolum* Dall differing mainly in having sharply angled whorls and a much coarser sculpture.

It appears to be a rare species, which occurs at intermediate depths of about 30 to 100 fathoms to judge from the few records available. It probably has a much wider range than that indicated by records.

Range. Southeast Florida and west Florida to Yucatan.

Specimens examined. FLORIDA: off Lake Worth in 66 fathoms (ANSP; MCZ); off Lantana in 40 fathoms (T. McGinty); Oregon, station 937, about 90 miles W of Egmont Key (27°30' N; 84°14' W) in 38 fathoms (H. Bullis); SSE of Pensacola in 37 fathoms (T. McGinty). MEXICO: About 140 miles ENE of Alacran Reef, Yucatan in 69 fathoms (D. Steger; T. McGinty).

Calliostoma (Calliostoma) jucundum Gould

Plate 3, fig. 2; Plate 8, fig. 2; Plate 17

Trochus jucundus Gould 1849, Proc. Boston Soc. Nat. Hist. **31**: 91 (New Zealand); Gould 1852, United States Exploring Expedition **12**: 177, pl. 12, figs. 209a-b; Gould 1862, Otia Conchologica, p. 56.

Calliostoma rioensis Dall 1890, Proc. United States Nat. Mus. **12**: 345, pl. 12, fig. 5 (Rio de Janeiro, Brazil); Clench 1938, Mem. Soc. Cubana Hist. Nat. **12**: 376.

Calliostoma bellicosum von Ihering 1907, Anales del Museo Nacional de Buenos Aires (3) **7**: 439, pl. 17, fig. 117 (Pampien and post-Pampien formation of Bahía Blanca, Argentina).

Calliostoma lahillei von Ihering 1907, Anales del Museo Nacional de Buenos Aires (3) **7**: 440, pl. 17, fig. 118 (Punta Villarino, northern Patagonia, Argentina).

Calliostoma (rioense var. ?) *hermosanum* Dall 1927, Proc. United States Nat. Mus. **70**: 6 (Monte Hermosa, Argentina).

Calliostoma jucundum Gould. Clench 1938, Mem. Soc. Cubana Hist. Nat. **12**: 376.

Description. Shell reaching 22.5 mm. (about $\frac{7}{8}$ of an inch) in length, turbinate, solid in structure, rather coarsely sculptured and imperforate. Color a pinkish brown and mottled with white and red-brown. Whorls 8, flat sided and with a rounded keel. Base of shell flat to slightly convex. Spire somewhat extended and produced at an angle of 55° to 70°. Aperture subquadrate, the outer lip simple and produced at an angle of 40° from the base. Columella somewhat thickened and slightly oblique. Suture slightly indented but relatively obscure. Sculpture consisting of 7 to 8 beaded cords above the periphery

and 12 smooth to finely beaded cords on the base of the whorl. Operculum circular, multispiral and chitinous. Nuclear whorl one, minute, opaque, white and smooth.



Plate 17. *Calliostoma jucundum* Gould. Fig. 1. Holotype of *C. hermosanum* Dall [= *C. jucundum* Gould], from Monte Hermoso, Argentina (3.2). Holotype of *Trochus jucundus* Gould [= *C. jucundum* Gould], from "New Zealand," Brasil (4.6x). Fig. 3. Holotype of *C. rioense* Dall [= *C. jucundum* Gould], from Encreados Islets, Rio de Janeiro, Brasil (4.8x).

length	width	
22.5 mm.	18.3 mm.	Mar del Plata, Argentina
13	12.5	Holotype of <i>C. rioense</i> Dall
10	9.5	Holotype of <i>C. jucundum</i> Gould

Types. The holotype of *C. jucundum* Gould is in the United States National Museum, no. 5609 and a paratype is in the Museum of Comparative Zoology, no. 38059. The locality New Zealand given by Gould was in error. Other specimens of this species also collected by the United States Exploring Expedition, now in the United States National Museum and the Museum of Comparative Zoology, are labeled Rio de Janeiro, Brasil, and this is here considered to be the type locality. The type of *C. rioense* Dall is in the United States National Museum, no. 18716 from Encuados Islets, Rio de Janeiro, Brasil, collected by the United States Exploring Expedition. Paratypes from *Albatross*, station 2762, off Rio de Janeiro (23°08' S; 41°34' W) in 59 fathoms are in the United States National Museum, no. 96139. The holotype of *C. hermosanum* Dall from Monte Hermosa, Argentina is in the United States National Museum, no. 152887.

The holotypes of *C. bellicosum* von Ihering which was described from the Pampien formation of Bahía Blanca, Argentina (Pleistocene) and that of *C. lahillei* von Ihering from Punta Villarino, northern Patagonia, Argentina are probably in the Musée de São Paulo, Brasil.

Remarks. Based upon shell characters this species is close in its relationship to *C. pulchrum* C. B. Adams. It differs from *pulchrum*, however, by being somewhat larger, and

in having a reddish brown rather than ivory-white ground color. The beaded cords of *jucundum* are much coarser and more uniform in size. The jaws and radulae are very similar (see Plate 3). These two species have widely separated ranges.

Calliostoma rioense Dall was based on material collected by the United States Exploring Expedition, probably from a portion of the same lot used by Gould in describing *jucundum*. This was another unfortunate error brought about by the loss of data in many of the lots collected by the Exploring Expedition. Dall mentioned the great similarity between his new species and *jucundum* Gould which at that time was still thought to be from New Zealand.

Range. From Rio de Janeiro, Brasil south to Cabo Bermeja, Argentina.

Specimens examined. BRASIL: Rio de Janeiro (MCZ; USNM); Praia do Leste, Ilha Guaíba, Est. do Rio de Janeiro (P. de Oliveira). URUGUAY: Cabo Polonia; Puerto de la Polonia, Cabo Santa Maria; Cabo Santa Maria (all USNM). ARGENTINA: *Albatross*, station 2764, off Río de la Plata (36°42' S; 56°23' W) in 12 fathoms; *Albatross*, station 2765, off Río de la Plata (36°43' S; 56°23' W) in 10 fathoms; *Albatross*, station 2766, off Río de la Plata (36°47' S; 56°23' W) in 10½ fathoms (all USNM); Mar de la Plata (MCZ; USNM); Puerto San Blas, Prov. Río Negros (A. Carcelles); off Cabo Bermeja (41°17' S) *Hassler* Voyage, in 17 fathoms (MCZ).

***Calliostoma (Calliostoma) coppingeri* Smith**

Plate 4, fig. 1; Plate 18

Trochus (Ziziphinus) coppingeri E. A. Smith 1880, Annals and Magazine of Natural History (5) 6: 320 (off the mouth of the Río de la Plata, 36°47' S; 55°17' W, in 28 fathoms).

Calliostoma coppingeri Smith. Dall 1889, Proc. United States Nat. Mus. 12: no. 7, p. 344, pl. 12, fig. 4.

Calliostoma coppingeri var. *cymatium* Dall 1889, Proc. United States Nat. Mus. 12: no. 7, p. 343 (*Albatross*, station 2768, off Cape Delgado in 43 fathoms).

Calliostoma coppingeri Smith. Carcelles 1944, Revista de la Plata (NS) Zoologia 3: 240.

Description. Shell reaching 11 mm. (about ½ inch) in length, trochoid in shape, rather light in structure, imperforate, and rather finely sculptured. Color ivory-white and iridescent. Whorls 6½, convex, with a broad and flattened keel at the whorl periphery. Base of shell convex. Spire moderately extended and produced at an angle of 70° to 80°. Aperture subquadrate, outer lip simple and produced at an angle of 50° from the base. Columella broad, inwardly arched and obtusely angled with the base of the aperture. Suture distinct. Sculpture variable, consisting of numerous fine, spiral threads which may be smooth or very finely beaded. The broadened, flattened keel is margined by two stronger threads which are generally beaded, particularly on the early whorls. The sub-sutural cord is often stronger than the remaining cords and may be beaded. Nuclear whorls one, smooth and glass-like. Operculum thin, corneous and multispiral.

length	width	
11 mm.	12.5 mm.	60 miles E of Peninsula Jabalí, Argentina
10	11.6	“ “ “ “
11.5	12	“ “ “ “
12.5	13.5	Mar del Plata, Argentina

Types. The holotype of *C. coppingeri* E. A. Smith is in the British Museum (Natural History). The type locality, off the mouth of Río de la Plata, Uruguay, as given by Smith is, in reality, about 88 miles SE of Cabo San Antonio, Province of Buenos Aires, Argentina. It was found at 36°47' S; 55°17' W in 28 fathoms, taken by the HMS *Alert*.



Plate 18. *Calliostoma coppingeri* Smith. Figs. 1-2. Mar del Plata, Prov. Buenos Aires, Argentina (about 4.7x). Figs. 3-4. *Hassler*, station 27, about 60 miles E of Peninsula Jabali, Argentina in 30 fathoms (4.8x). Fig. 5. Holotype of *C. coppingeri* var. *cymatium* Dall [= *coppingeri* Smith], *Albatross*, station 2768, off Cape Delgado, Argentina in 43 fathoms (4.8x).

Remarks. The species appears like a diminutive *C. atlantis*, though it is proportionately more coarsely sculptured and the space between the upper and lower peripheral cords is straight rather than concave.

On the basis of material available, this species ranges in depth from the littoral zone to about 45 fathoms, living on rocky shell bottoms and mussel beds. According to Carcelles (1938) it is commonly fed upon by *Astropecten cingulatus* Sladen.

Range. From off Maldonado, Uruguay south to Peninsula Valdes, Argentina (42°24' S). The record given by Carcelles for Rio de Janeiro appears to be in error. We have not seen any material of this species from Brasil.

Specimens examined. URUGUAY: off Maldonado (USNM); *Hassler*, station 25, about 30 miles SW of Punta del Este, Uruguay (35°12' S; 55°30' W) in 7 fathoms (MCZ). ARGENTINA: *Albatross*, station 2765, about 18 miles NE of Punta Médanos, Prov. Buenos Aires (36°43' S; 56°23' W) in 10.5 fathoms; *Albatross*, station 2766, about 17

miles NE of Punta Médanos, Prov. of Buenos Aires ($36^{\circ}47'$ S; $56^{\circ}23'$ W) in 10.5 fathoms (both USNM); about 112 miles NE of Mar del Plata ($37^{\circ}31'$ S; $55^{\circ}33'$ W) in 48 fathoms; 38 miles NNE of Mar del Plata ($37^{\circ}36'$ S; $57^{\circ}05'$ W) in 7 fathoms (both Museo Poey); about 80 miles E of Mar del Plata, Prov. Buenos Aires ($37^{\circ}42'$ S; $56^{\circ}20'$ W) in 44 fathoms; off Puerto Quequén, Prov. Buenos Aires; *Hassler*, station 27, about 60 miles E of Peninsula Jabalí ($40^{\circ}22'$ S; $60^{\circ}35'$ W) in 30 fathoms; *Hassler*, station 28, about 22 miles S of Punta Redonda ($41^{\circ}17'$ S; $63^{\circ}00'$ W) in 17 fathoms; *Hassler*, station 30, about 45 miles S of Punta Redonda ($41^{\circ}40'$ S; $63^{\circ}13'$ W) in 30 fathoms (all MCZ); *Albatross*, station 2768, about 90 miles due E of Peninsula Valdez ($42^{\circ}24'$ S; $61^{\circ}38'$ W) in 43 fathoms (USNM).

***Calliostoma (Calliostoma) yucatecanum* Dall**

Plate 4, fig. 4; Plate 8, fig. 4; Plate 19

Calliostoma yucatecanum Dall 1881, Bulletin Museum Comparative Zoology **9**: 47 (*Blake* station in Yucatan Strait in 640 fathoms); Dall 1889, Bull. Museum Comp. Zool. **18**: 370, pl. 24, figs. 4-4a.

Calliostoma (Astele) agalma Schwengel 1942, Notulae Naturae, no. 106, pp. 1-2, fig. 1 (off Destin, Florida in 18-20 fathoms).

Description. Shell reaching 15 mm. (about $\frac{2}{3}$ of an inch) in length, trochoid in shape, rather solid in structure, umbilicate and rather finely sculptured. Color a light pink with numerous and irregular patches of light brown on the spiral cords. Whorls 8, slightly convex and produced at an angle of about 85° . Aperture subcircular, the outer lip simple and produced at an angle of about 35° from the base. Columella white, arched and truncated. Umbilicus white, narrow, deep and smooth. Cords margining the umbilicus smooth or only slightly beaded. Suture very indistinct. Sculpture consisting of numerous cords. On the early whorls there are three to four large cords which are faintly beaded and between these are numerous thread-like cords which are also faintly beaded. The cords on the later whorls of adult specimens are usually smooth, though occasionally there is a faint indication of beading. Below the periphery there are 9 to 13 large cords with a few small thread-like cords in between. Embryonic whorl one, white and smooth. Operculum circular, corneous, thin, multispiral, with a central nucleus and exceedingly small nuclear whorls.

length	width	
15 mm.	15.5 mm.	off Flagler Beach, Florida
13.5	13.5	off Yucatan
12.5	13.5	off Brunswick, Ga.
12	13.5	off Savannah River, Ga.
7.5	10	off Cedar Keys, Fla.
7	9.5	Holotype of <i>C. agalma</i>
6.5	9	Paratype of <i>C. agalma</i>
7	9	Holotype of <i>C. yucatecanum</i>

Types. The holotype of *Calliostoma yucatecanum* Dall is in the Museum of Comparative Zoology, no. 7567 from the Yucatan Strait off Yucatan in 640 fathoms, collected by the *Blake*.

The holotype of *C. agalma* Schwengel from off Destin, Florida in 18 to 20 fathoms is in the Academy of Natural Sciences Philadelphia, no. 178758. Paratypes from the same

locality are in the Museum of Comparative Zoology, no. 204717 and the United States National Museum, no. 617432.

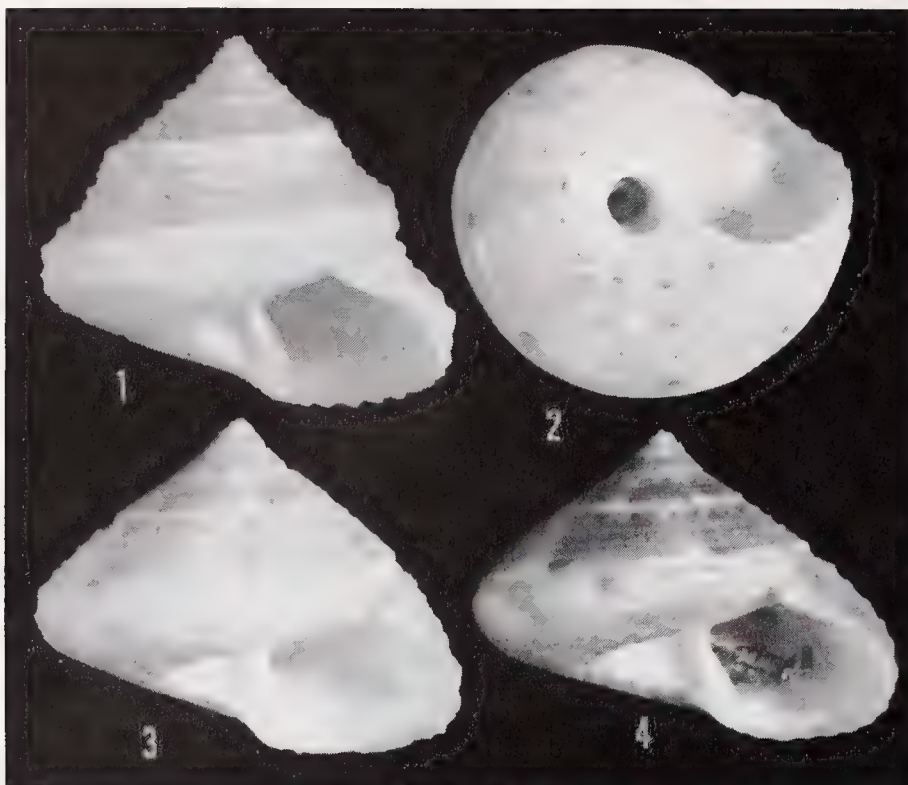


Plate 19. *Calliostoma yucatecanum* Dall. Fig. 1. *Blake* (no station number), Yucatan Strait in 640 fathoms. Holotype of *C. yucatecanum* Dall. Fig. 2. Off Destin, Florida in 18-20 fathoms. Paratype of *C. agalma* Schwengel [= *C. yucatecanum* Dall]. Fig. 3. Off Fort Walton, Florida. Fig. 4. Off Destin, Florida in 18-20 fathoms. Holotype of *C. agalma* Schwengel [= *C. yucatecanum* Dall]. (All about 4.6x.)

Remarks. This species is quite different from all the umbilicate forms we have dealt with from the Western Atlantic. The convex spire and the type of sculpturing are very characteristic and readily distinguish it.

It is questionable that this species lives at the depth of 640 fathoms as given for the *Blake* station in the Yucatan Channel as all other depth records range from 5 to 35 fathoms. The *Blake* specimen was alive when taken, however. There are some questions in our minds regarding this "station" of the *Blake*. Many lots in the *Blake* collections simply carry "Yucatan Channel in 640 fathoms" with no station number. Mr. Sander-son Smith¹ who listed all the dredging stations of the *Blake* along with other vessels which had dredged from 1867 to 1887 gave no station number showing a depth of 640 fathoms.

We introduce this note here just in case other discrepancies may be noted later among other species.

The occurrence of this species in the relatively shallow water off the coast of North Carolina, northern Florida and Georgia may possibly date from the time of the Suwannee Trough which extended across northern Florida in the Pliocene. Future dredging may very well extend the range of this species south along the east coast of Florida. It did not appear, however, among the large collections made by the *Eolis* dredgings along the Lower Keys of Florida.

Range. Off North Carolina to northern Florida and the Gulf of Mexico from north-west Florida west to Texas and south to Yucatan.

¹S. Smith 1888, Annual Report of the Commissioner of Fish and Fisheries for 1886, pp. 963-972.

Specimens examined. NORTH CAROLINA: *Albatross*, station 2607 about 18 miles due east of Cape Lookout (34°38' N; 76°12' W) in 18 fathoms; *Albatross*, station 2605, about 46 miles E of Cape Lookout (34°35' N; 75°45' W) in 35 fathoms; *Albatross*, station 2615, about 31 miles ESE of Cape Fear (33°45' N; 77°24' W) in 18 fathoms (all USNM). SOUTH CAROLINA: *Pelican*, station 182-22, about 33 miles E of Bulls Island (32°52' N; 79°04' W) in 11 fathoms (USNM). GEORGIA: *Pelican*, station 180-5, about 23 miles SE of the mouth of the Savannah River (31°53' N; 80°34' W) in 8 fathoms; *Pelican*, station 197-1, about 36 miles NE of Brunswick (31°31' N; 81°01' W) in 5 fathoms; *Pelican*, station 178-16, about 80 miles ENE of Brunswick (31°21' N; 80°12' W) in 21 fathoms; *Pelican*, station 178-6, about 35 miles E of Brunswick (31°11' N; 80°52' W) in 9 fathoms; *Pelican*, station 178-5, about 31 miles E of Brunswick (31°10' N; 80°56' W) in 8 fathoms; *Pelican*, station 177-11, about 24 miles SE of Brunswick (30°59' N; 81°06' W) in 9 fathoms (all USNM). FLORIDA: *Pelican*, station 213-1, about 2 miles SE of Flagler Beach, Flagler Co. (29°28' N; 81°06' W) in 5 fathoms (USNM); Long Boat Key, Sarasota (M. L. Chambers); SW of Egmont Key, Tampa Bay, in 29 fathoms (D. Steger); *Albatross*, station 2374, about 71 miles W of Cedar Keys (29°11' N; 85°29' W) in 26 fathoms (USNM); *Oregon*, station 891, about 118 miles W of Cedar Keys (29°00' N; 85°02' W) in 21 fathoms (H. Bullis); off Panama City in 21 fathoms (T. McGinty); off Destin in 20 fathoms (T. McGinty, H. & K. Johnstone); off Fort Walton in 13-19 fathoms (MCZ, UMML). ALABAMA: *Albatross*, station 2387, about 66 miles S of Mobile Bay (29°24' N; 88°04' W) in 32 fathoms (USNM). TEXAS: Off Port Isabel in 10½ fathoms (R. H. Parker). MEXICO: 170 miles NE of Progreso, Yucatan in 10-15 fathoms (T. McGinty); *Albatross*, station 2362, about 40 miles N of Cabo Catoche (22°08' N; 86°53' W) in 25 fathoms (USNM); *Blake* (no station number), Yucatan Strait in 640 fathoms (MCZ).

Subgenus **Elmerlinia**, new subgenus¹

Shell perforate in all known species, marked with axial flames of reddish brown or nearly unicolored. Sculpture with beaded cords. Aperture subquadrate with the columella arched and truncated at the base.

Radula with a central tooth having serrate or denticulate margins, six lateral teeth, four of which are denticulate, the two outer laterals plate-like or with extremely slender cusps. First two marginal teeth narrow with rather large denticulations; remaining marginal teeth long and finely denticulate (see Plate 5).

Jaws long, with the anterior ends sharply rounded and with a long fringe at the anterior margin (see Plate 9).

Type species, *Calliostoma jujubinum* Gmelin.

Calliostoma (Elmerlinia) javanicum Lamarck

Plate 20, figs. 1-4

Trochus javanicus 1822, Histoire Naturelle des Animaux Sans Vertèbres 7: 25 (Java); Delessert 1841, Recueil de Coquilles décrites par Lamarck, Paris, pl. 35, figs. 2a-b; P. Fischer [in] Kiener 1875 Coquilles Vivantes 11: pl. 17, fig. 5.

Zizyphinus zonamestus A. Adams 1851 [1853] Proc. Zoological Society London, p. 166 (Honduras).

¹ Named for our three young, enthusiastic Saturday helpers, Elsa Nyberg, Meredith Turner and Madeline Pini.

Description. Shell reaching 29 mm. (about $1\frac{1}{4}$ inches) in length, trochoid in shape, rather solid in structure, umbilicate and finely sculptured. Color variable, usually a light brownish red which may appear somewhat mottled, or a tan mottled with brownish orange markings. In addition, there are usually spiral bands of red-brown between the spiral cords. Whorls 9 to 10, flat sided and with a sharp peripheral keel. Base of shell nearly flat. Spire moderately extended and produced at an angle of about 65° . Aperture subquadrate, the outer lip simple and slightly crenulated. It is cast at an angle of about 50° from the base. Columella strongly arched, thickened, white and with a slight truncation. Umbilicus profound, white in color, narrowly funnel-shaped and bordered by a coarsely beaded cord. Sutures very indistinct. Spiral sculpture consisting of numerous fine beaded cords. Axial sculpture consisting of very fine diagonal ridges in between the cords. On the base, just below the peripheral keel, there is a nearly smooth area devoid of beaded cords. In profile, this appears as a somewhat flattened area with a slight depression on its inner margin. The remainder of the base is sculptured with 12–13 beaded cords which are considerably finer than those above the keel.

length	width	
23.5 mm.	31 mm.	Garden Key, Dry Tortugas, Florida
29	31	St. Kitts, Lesser Antilles
27.5	29.5	St. Thomas, Virgin Islands
33	35	Arenas de la Chorrera, Habana, Cuba

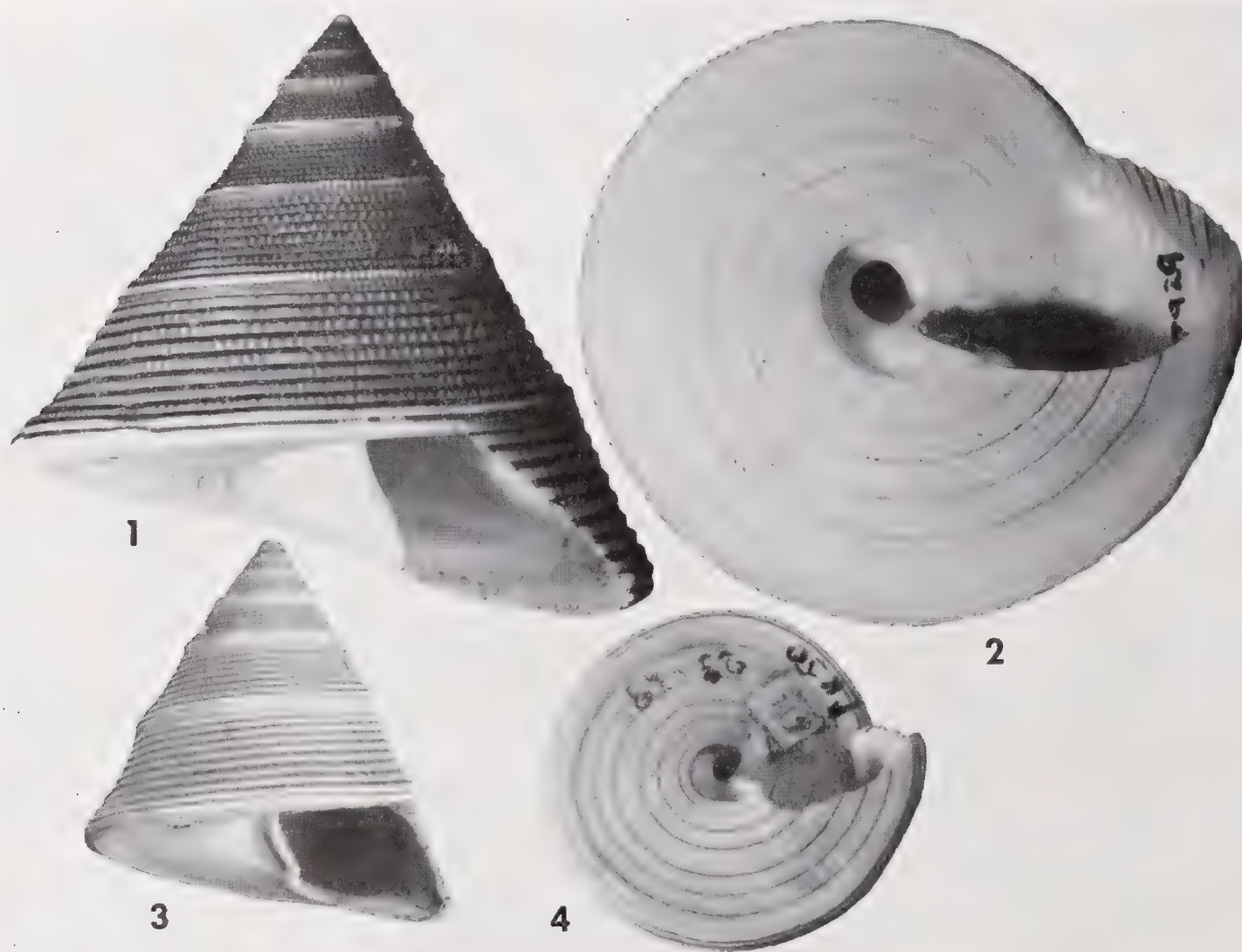


Plate 20. *Calliostoma javanicum* Lamarck. Fig. 1. St. Kitts, Lesser Antilles (2.4x). Fig. 2. Garden Key, Dry Tortugas, Florida (2.4x). Figs. 3 and 4. Holotype of *Trochus javanicus* Lamarck. Photographs through the courtesy of the Muséum d'Histoire Naturelle, Genève, Switzerland (2x).

Types. The holotype of *Trochus javanicus* Lamarek is in the Geneva Museum. Through the kindness of Dr. E. Binder, Curator of Mollusks of the Muséum d'Histoire Naturelle, Genève, we are able to figure the holotype.

The type of *Zizyphinus zonamestus* A. Adams is probably in the British Museum.

Remarks. *C. javanicum* is fairly close in its relationships to *C. jujubinum*, differing from *jujubinum* in being proportionately wider, having a larger umbilicus as well as a more acute peripheral carina. The beaded sculpture is more regular in *javanicum* both above and below the periphery. In *jujubinum* there is much variation in the size of the beaded cords. The jaws and radulae are very similar in both species.

Range. From southern Florida, the Bahamas and south through the Greater and Lesser Antilles to Panama.

Specimens examined. FLORIDA: Yamato (ANSP); Bache Shoal, off Elliott Key (UMML); Garden Key, Dry Tortugas (T. Bayer). BAHAMA ISLANDS: Bimini Island (UMML). CUBA: Arenas de la Chorrera, Habana (MCZ; V. Conde); Banes (D. Steger); Cuzco Beach, Guantánamo Naval Base (MCZ). JAMAICA: Negril, West Moreland (USNM). PUERTO RICO: Punta Agujereada; Punta Algorrobo (both G. Warmke). VIRGIN ISLANDS: St. Thomas (USNM); Tortola (ANSP); Cane Bay, St. Croix (G. Usticke). LESSER ANTILLES: St. Kitts (USNM); Dominica (T. McGinty); Barbados (MCZ). CARIBBEAN ISLANDS: Aruba (J. A. Webber). PANAMA: Colón (T. McGinty).

Calliostoma (Elmerlinia) jujubinum Gmelin

Plate 5, fig. 2; Plate 9, fig. 1; Plate 21

Trochus jujubinus Gmelin 1791, Systema Naturae, ed. 13, p. 3570 (ad insulam S. Mauritii, et in mari Americam australem alluente); non *T. jujubinus* Röding 1798.

Trochus lunatus Röding 1798, Museum Boltenianum, p. 82 (refers to Chemnitz 1781 (1), 5: pl. 167, figs. 1612-1613).

Trochus perspectivus 'Koch' Philippi 1843, Abbildungen und Beschreibungen Conchylien 1: 32, pl. 1, fig. 5 (locality unknown); non *Trochus perspectivus* Linné 1758; non *T. perspectivas* A. Adams 1864.

Trochus tampaensis Conrad 1846, Proc. Academy Natural Sciences Philadelphia 3: 26, pl. 1, fig. 35 (Tampa Bay [Florida]).

Eutrochus alternatus Sowerby Nov. 1873 [April 1874], Proc. Zool. Soc. London, p. 719, pl. 59, fig. 5 (Australia?).

Calliostoma (Eutrochus) jujubinum rawsoni Dall 1889, Bulletin Museum Comparative Zoology 18: 369 (St. Croix [Virgin Islands]).

Description. Shell reaching 34 mm. (about $1\frac{3}{8}$ inches) in length; trochoid in shape, solid in structure, umbilicate, and finely sculptured. Color ranging from a uniform dark mahogany-brown to a yellowish brown and generally marked with irregular blotches of a lighter tone at the periphery of the whorl. Whorls 9 to 10, generally flat-sided and with a somewhat angled or rounded keel. Base on young shells flat and sometimes slightly concave, while in the adult stage the keel is rounded and the base slightly convex. Occasionally the keel bulges slightly beyond the contour of the rest of the whorl and so forms a spiral ridge at the suture. Spire somewhat extended and produced at an angle of from 50° to 60° . Aperture subquadrate, the outer lip simple and produced at an angle of about 42° from the base. In adult specimens, there is a series of small ridges inside of the outer

lip which extend well within the aperture. Columella white, thickened to form a ridge, arched inwardly and truncated at the base in adults. Umbilicus white, narrow, deep, smooth, and bordered by beaded cords. Suture indistinct, particularly on the early whorls. Sculpture somewhat variable, consisting of numerous rather fine beaded cords. These cords may be of two or more sizes, the coarser cords alternating with the finer ones, particularly on the base of the shell. In most adult specimens the cords over the rounded keel are much finer, more closely set and less strongly beaded and occasionally smooth. Operculum circular, entirely corneous, thin, with a central nucleus and multi-spiral coiling. Microscopic sculpture on the operculum consisting of numerous and exceedingly fine radiating threads.

The sole of the foot is ivory-white, smooth, the sides papillose, spaces between the papillae a dark chocolate brown, the papillae white. Anterior portion of the head and snout is maculated with brown, the tentacles and posterior portion of the head area a uniform dark brown. Edge of the mantle has irregular patches of dark brown.

length *	width	
18.5 mm.	21 mm.	Lectotype of <i>T. tampaensis</i> Conrad
34	29	Looe Key, off Big Pine Key, Florida
31	28	Washerwoman Shoals, off Boca Chica Key, Florida
30	25.5	Arenas de la Charrera, Habana, Cuba
23	22.5	St. Croix, Virgin Islands
20	16	E. of Alacran Reef, Yucatan, Mexico

* All specimens measured were adult showing the truncated columella and the ridges in the aperture.

Types. The lectotype, here selected, of *Trochus tampaensis* Conrad from Tampa Bay, Florida is in the Academy of Natural Sciences, Philadelphia, no. 40659. The type figures of *Trochus jujubinus* Gmelin and *Trochus lunatus* Röding are figures 1612 and 1613 on Plate 167 of Chemnitz 1781, Conchylien-Cabinet (1) 5: 82, both authors having referred to the same figures. The type locality is here restricted to St. Croix, Virgin Islands, as from this locality we have material which is almost identical with the figures of Chemnitz. Chemnitz states that the species was from the West Indian Sugar Islands and St. Maurice [Mauritius]. The latter locality undoubtedly is in error. Gmelin took his localities from Chemnitz. The holotype of *C. j. rawsoni* Dall from St. Croix, Virgin Islands is in the United States National Museum, no. 94931.

Remarks. This is the most abundant shallow water species of *Calliostoma* in the Western Atlantic. It is found from the low tide area to depths of 80 fathoms. It lives on a variety of bottoms including rocks, broken shells, sand and sea-grass.

Calliostoma jujubinum varies considerably in the angle of the spire, the width of the umbilicus, and the extent to which the whorls may be inset. The coloration also varies in intensity, color and pattern.

See also *Remarks* under *C. javanicum* Lamarck.

The subgeneric name *Eutrochus* A. Adams has been used for various species in this genus based on the work of Dall (1889) who gave *T. javanicum* Lamarck as the type species. This was in error as only a single species was given by Adams in the original description of *Eutrochus*, *E. perspectivus* A. Adams [= *Astele subcarinata* Swainson] non *perspectivus* Philippi. Consequently, *Eutrochus* becomes an absolute synonym of *Astele*. See also the discussion of *Astele* under Notes at the end of this paper.

Range. From Florida west to Texas and south to Colombia; the Bahama Islands and south through all of the West Indies.

Specimens examined. FLORIDA: *Pelican*, station 172-5, 28 miles NE of New Smyrna, Volusia Co. (29°16' N; 80°33' W) in 15 fathoms; *Pelican*, station 207-6, 9 miles SE of Cape Canaveral (28°20' N; 80°27' W) in 8 fathoms; 27 miles ENE of Melbourne Beach, Brevard Co. in 18 fathoms (all USNM); off Palm Beach in 75 fathoms (MCZ); Lake Worth Inlet (UMML); off Ocean Ridge, Palm Beach Co.; off Lantana in 80 fathoms; off Boynton in 10 fathoms (all MCZ); Hillsboro (D. Moore; UMML); off Government Cut, Miami in 27 fathoms (T. McGinty); *Eolis*, station 62, off Miami in 20 fathoms (USNM); Bakers Haulover, Biscayne Bay (R. Humes); Soldier Key, Biscayne Bay (T. McGinty); *Eolis*, station 129, off Fowey Light, Biscayne Bay, in 48 fathoms

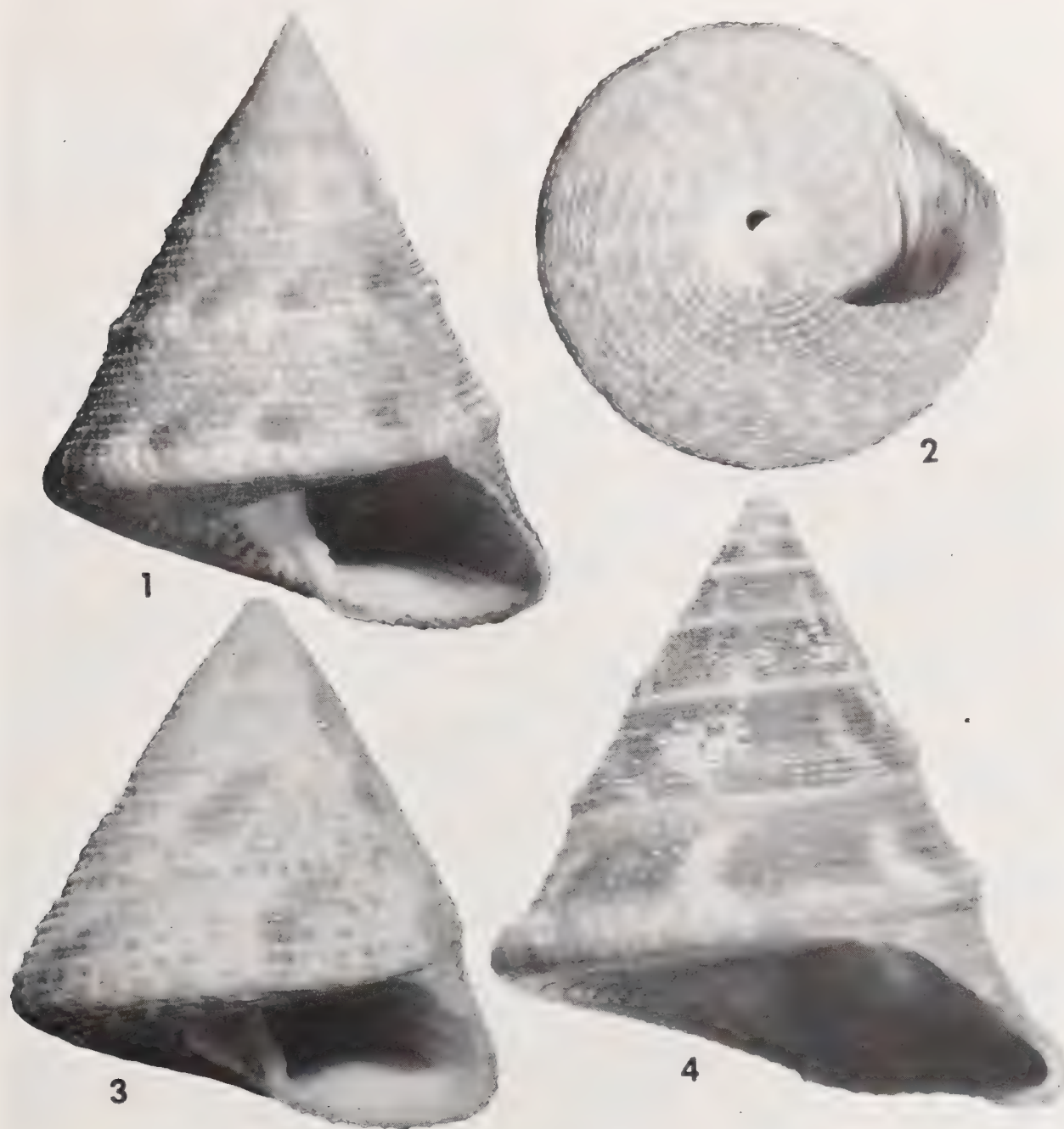


Plate 21. *Calliostoma jujubinum* Gmelin. Fig. 1. Off Campeche, Yucatan, Mexico in 60 fathoms (about 2.4x). Fig. 2. Dead Mans Bay, Florida (about 2.4x). Fig. 3. Holotype of *Trochus tampaensis* Conrad [= *C. jujubinum* Gmelin], Tampa Bay, Florida (about 3.2x). Fig. 4. Holotype of *Eutrochus rawsoni* Dall [= *C. jujubinum* Gmelin], St. Croix, Virgin Islands (about 5.4x).

(USNM); Long Reef, off Elliott Key (A. Merrill); Dry Rocks, Key Largo (ANSP; UMML); French Reef, Key Largo (H. and K. Johnstone); Molasses Reef, Key Largo in 45 fathoms (T. McGinty; J. A. Weber); Lower Matecumbe Key (UMML); Ohio Key (J. A. Weber); No Name Key (ANSP); Bahia Honda Key (USNM); Looe Key, off Big Pine Key (MCZ); Washerwoman Shoals, off Boca Chica Key (J. S. Schwengel); Boca Chica Key (D. and N. Schmidt); Middle Sambo Shoal, Key West (ANSP; T. McGinty); Pelican Shoals, Key West (T. McGinty); Key West in 2 fathoms (J. S. Schwengel); Eastern Dry Rocks, Key West (H. and K. Johnstone; UMML); *Eolis*, station 101, off Sand Key, Key West in 38 fathoms (USNM); Tortugas (USNM; CM; T. McGinty; UMML); *Oregon*, station 1022, off Tortugas (24°59' N; 83°35' W) in 39 fathoms (H. Bullis); Loggerhead Key (USNM); FLORIDA (West Coast): 15 to 35 miles off Fort Walton (MCZ); *Albatross*, station 2774, about 30 miles S of Cape San Blas (29°11' N; 85°29' W) in 26 fathoms; *Albatross*, station 2406, about 55 miles S of Apalachicola (28°46' N; 84°49' W) in 26 fathoms (both USNM); off Panama City in 21 fathoms (T. McGinty); Alligator Harbor, Franklin Co. (R. Work); Dead Man's Bay, Dixie Co. (MCZ); off Cedar Keys in 15 fathoms (MCZ; H. Bullis); off North Key, Cedar Keys (H. and K. Johnstone); off Tarpon Springs (J. S. Schwengel); Clearwater (S. Kaicher; ANSP); Boca Ciega Bay, St. Petersburg (CM); SSW of John's Pass, St. Petersburg in 29 fathoms (D. and B. Steger); Tampa Bay in 4 fathoms (USNM); Bradenton (J. A. Weber); *Oregon*, station 961, off Bradenton (27°01' N; 83°27' W) in 25 fathoms (H. Bullis); Anna Maria Key, Sarasota (USNM); Long Boat Key, Sarasota (L. Chambers); Gasparilla Id. (ANSP; USNM); Pineaire, Pine Island (D. and N. Schmidt); Lacosta Id., Charlotte Harbor (MCZ); Sanibel Id. (CM; MCZ; D. and N. Schmidt); Punta Rassa, Lee Co. (MCZ; ANSP); Fort Myers Beach (D. and N. Schmidt; ANSP); Bonita Springs (CM; D. and N. Schmidt); Naples, Lee Co. (MCZ; ANSP; T. McGinty); Marco (MCZ; CM; USNM; T. McGinty); Caxambas Pass, 5 miles S of Marco (MCZ); near Cape Romano (D. and N. Schmidt; ANSP; USNM); Kice Id., Cape Romano (D. and N. Schmidt); *Oregon*, station 993, off Cape Romano (25°50' N; 81°52' W) in 6 fathoms (H. Bullis). TEXAS: *Atlantis*, station about 210 miles E of Corpus Christi (27°53' N; 93°48' W) in 20 fathoms (MCZ). BAHAMA ISLANDS: Great Abaco; Nassau, New Providence (MCZ; G. and M. Kline); Alice Town, Bimini Ids. (MCZ); North Bimini Id., Bimini Ids. in 20 fathoms (USNM); Frazier Hog Cay, Berry Ids. (T. McGinty); Staniard Creek, Andros Id. (G. and M. Kline; MCZ; ANSP); Pigeon Cays, Andros Id. (T. McGinty; G. and M. Kline; MCZ); Arthurs Town, Cat Id. (MCZ); Conception Id. (G. and M. Kline). CUBA: Cabo San Antonio, Pinar del Río; off Los Arroyos, Pinar del Río (both USNM); Arenas de la Chorrera, Habana (MCZ; V. Condé); off Bahía de Cárdenas, Matanzas (ANSP); Pueblo Nuevo, Matanzas (MCZ); off Punta de Hicacos in 11 fathoms and off Cayo Blanco in 15 fathoms, Cárdenas, Matanzas (V. Condé); Cayo Santa Maria, off Punta Alegre, Camagüey (R. Humes); Guantánamo Bay, Oriente (MCZ). JAMAICA: (MCZ). PUERTO RICO: about $\frac{3}{4}$ mile N of Punta Garza in 33–40 fathoms (USNM); Ramey Air Force Base; Rincon; Punta Algarrobo; Punta Arenas; near Cabo Rojo Light House (all G. Warmke; MCZ); Vieques Id. (USNM). VIRGIN ISLANDS: The Baths, Virgin Gorda; Guana Id. and Scrub Id., Tortola (all M. W. Dewey); Water Id., St. Thomas (J. A. Weber); St. Thomas (MCZ; USNM); St. John (M. W. Dewey; ANSP); St. Croix (MCZ; G. Usticke; USNM). LESSER ANTILLES: Parham Sound, Antigua (CM);

Anguilla and Antigua Id. (both G. Usticke). CARIBBEAN ISLANDS: Aruba, Dutch West Indies (USNM; J. A. Weber). HISPANIOLA: Santa Bárbara de Samaná, Santo Domingo (MCZ). MEXICO: Veracruz, Veracruz (ANSP; USNM); Tuxpan, Veracruz (T. Pulley); off Campeche, Yucatan in 60 fathoms (W. C. Frisbey); 170 miles NE of Progreso, Yucatan in 34 fathoms (T. McGinty); E of Alacran Reef, Yucatan in 27 fathoms (D. and B. Steger); *Albatross*, station 2366, about 60 miles N of Cabo Catoche ($22^{\circ}28' \text{ N}$; $87^{\circ}02' \text{ W}$) in 27 fathoms (USNM); off Isla Mujeres, Quintana Roo, Yucatan (MCZ; Museo Poey). PANAMA: Bocas del Toro, Colón (T. McGinty); Lemón Bay (J. A. Weber); 5 miles N of Colón (USNM) all Canal Zone. COLOMBIA: Carthagená (MCZ).

***Calliostoma (Elmerlinia) adela* Schwengel**

Plate 22, figs. 1-2

Calliostoma (Eutrochus) jujubinum adela Schwengel 1951, Nautilus 64: 119, pl. 8, figs. 4-5 (Indian Key, Florida).

Description. Shell reaching 18.5 mm. (about $\frac{3}{4}$ inch) in length, top shaped, rather solid in structure, umbilicate and finely sculptured. Color a light brown mottled with white. Whorls 8 to 10, generally flat sided and with a sharply angled keel. Spire somewhat extended and produced at an angle of about 60° . Aperture subquadrate, the outer lip simple and produced at an angle of about 50° from the base. In adult specimens there is a series of small ridges inside the outer lip which extend well within the aperture. Columella white, arched inwardly and thickened to form a ridge which is truncated at the base. Umbilicus white, rather narrow, deep, smooth and bordered by a beaded cord. Suture indistinct. Sculpture consists of numerous, rather fine, beaded cords. The two cords on the keel are larger, mottled with white and generally protrude somewhat at the suture. The remainder of the cords above the keel are rather evenly spaced and all are beaded. There may be 4 to 6 of these cords. There are 7 to 8 finely beaded cords on the base of the shell. Operculum thin, circular, corneous, with a central nucleus and multispiral coiling.

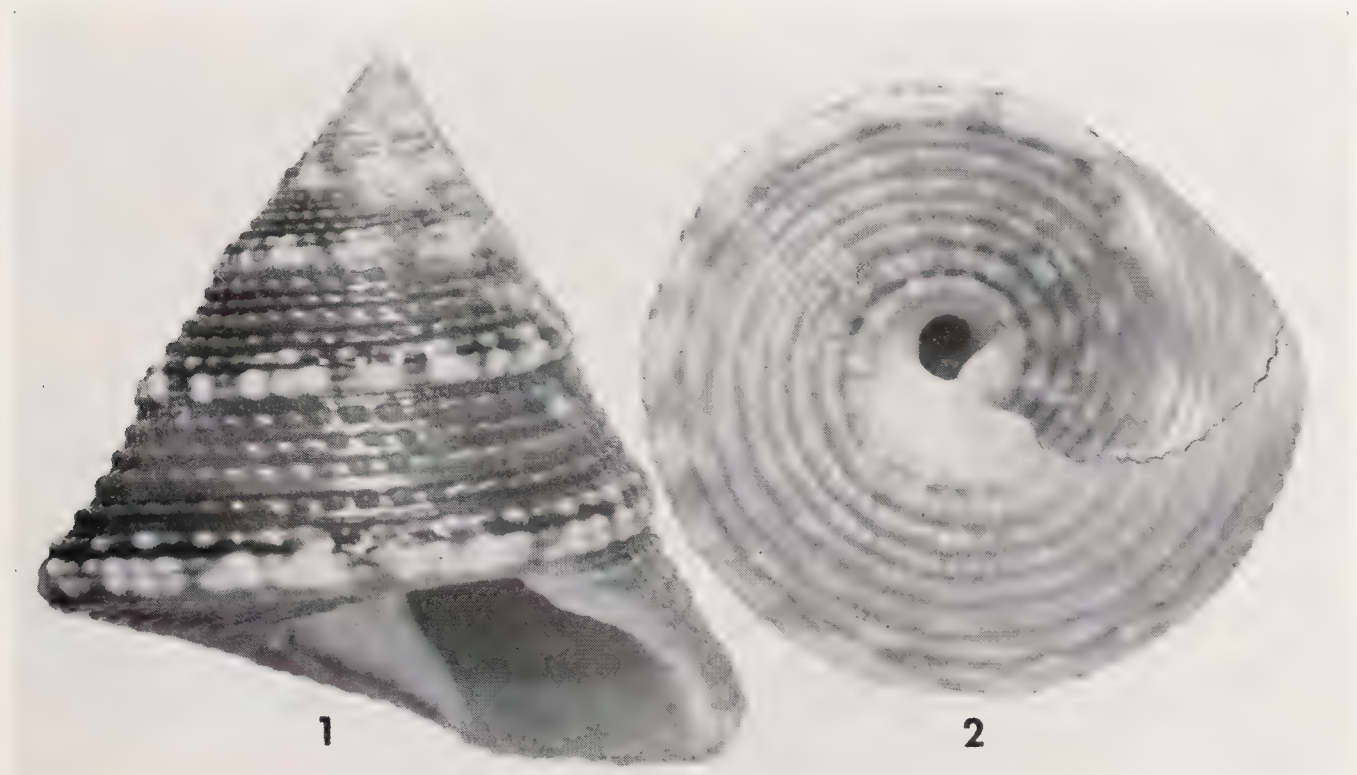


Plate 22. *Calliostoma adela* Schwengel. Fig. 1. Indian Key, Florida. Holotype. Fig. 2. Basal view of paratype from the same locality (both about 5.4x).

length	width	
15 mm.	14.5 mm.	Holotype
13.5	12	Paratype
18.5	17	Key Biscayne, Fla.
15	13.5	off Hillsboro Inlet, Fla.

Types. The holotype is in the Academy of Natural Sciences Philadelphia, no. 187203, from Indian Key, Lower Florida Keys. Paratypes from the same locality are in the Museum of Comparative Zoology.

Remarks. This species appears to be close in its relationships to *C. jujubinum*. It differs, however, by being, on the average, much smaller, and in having all of the spiral cords beaded, the peripheral cords on the keel being much larger than those above and below them. In *C. jujubinum*, the peripheral cords are generally finer than those on the rest of the whorl and are often smooth. On the base of *adelae* there are only 6 to 8 spiral cords which are of about equal strength, while in *jujubinum* there are 10 to 15 spiral cords which are strongest near the umbilicus but become progressively finer toward the periphery. Adult specimens of *jujubinum* have a rounded periphery while the periphery of *adelae* is strongly keeled.

Range. From Hillsboro Inlet, Florida, south through the Lower Florida Keys.

Specimens examined. FLORIDA: Hillsboro Reefs, off Hillsboro Inlet; Virginia Key (J. K. Howard); North Biscayne Bay; Biscayne Flats, Soldier Key (both T. McGinty); Key Biscayne (J. K. Howard); Key Largo (MCZ); Lower Matecumbe Key (USNM); Old Rhodes Key (MCZ); Tea Table Key (D. & N. Schmidt); Indian Key (A. Koto; J. S. Schwengel; T. McGinty; ANSP); Grassy Key (D. and N. Schmidt); No Name Key (USNM); Big Pine Key, east side old bridge (MCZ).

Calliostoma (Elmerlinia) bullisi, new species

Plate 5, fig. 1; Plate 9, fig. 2; Plate 23

Description. Shell reaching 24.2 mm. (about one inch) in length. Trochoid in shape, rather solid in structure, umbilicate and finely sculptured. Color a nearly uniform light pinkish brown mottled with a series of large dark reddish brown patches at the periphery. Whorls 8, slightly convex, with a rounded peripheral keel. Base of shell slightly convex in adult specimens. Spire moderately extended and produced at an angle of 80°. Aperture subquadrate. Outer lip simple and cast at an angle of about 40° from the base. Columella arched, thickened, white and truncated. Umbilicus profound and white. Sculpture consisting of numerous beaded spiral cords which may vary somewhat in size. There are from 30 to 34 cords on the body whorl. Nuclear whorls 1-1½, white and smooth. Operculum corneous, circular, multispiral; the nucleus not papilliform.

In preserved specimens of *C. bullisi*, the foot is red-brown in appearance when contracted, the color pattern being composed of very fine reticulations and streaks of red-brown and white papillose spots. The thickened edge of the mantle is marked with bands of diffused red-brown triangular flames, the inner band being diffused inwardly for a considerable distance. Top of head heavily streaked with the same color; tentacles, except at the base, a uniform red-brown.

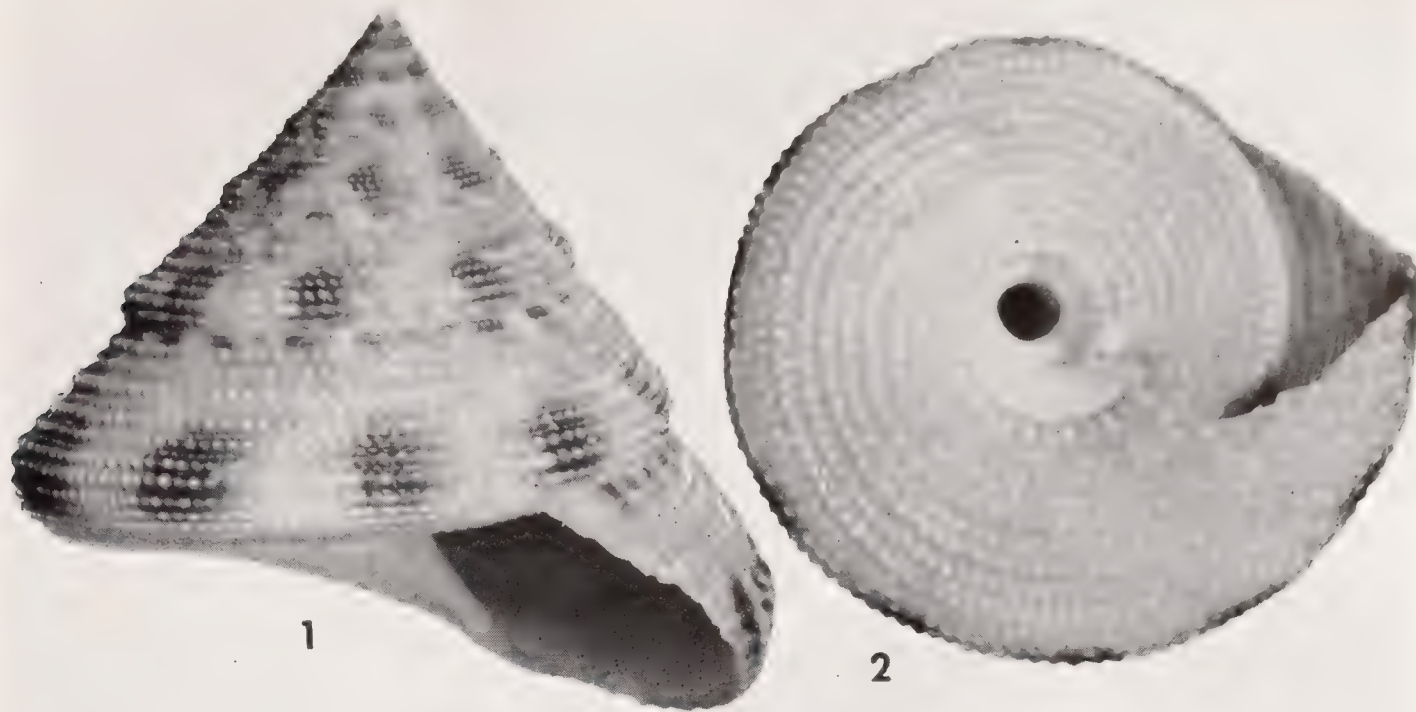


Plate 23. *Calliostoma bullisi* Clench and Turner. Fig. 1. *Oregon*, station 2049, about 65 miles ESE of Cabo Orange, Amapá, Brasil in 38 fathoms. Holotype. Fig. 2. *Oregon*, station 2050, about 75 miles ESE of Cabo Orange, Amapá, Brasil in 40 fathoms. Paratype (both about 4x).

length	width	
24.2 mm.	26.5 mm.	Holotype
21.5	23	Paratype

Types. The holotype of *C. bullisi* is in the United States National Museum, no. 612702, from the *Oregon*, station 2049, about 65 miles ESE of Cabo Orange, Amapá, Brasil (04°02' N; 50°33' W) in 38 fathoms. There are two paratype specimens from the same general area in the collection of H. Bullis.

Remarks. The shell characters of this species are close to *Calliostoma hassler* Clench and Aguayo, but differ in having a definite color pattern which is obscure in *C. hassler*. *Calliostoma bullisi* is proportionately wider and, in addition, has a truncated columella.

Range. Known only from the vicinity of Cabo Orange, Amapá, Brasil.

Subgenus **Kombologion**, new subgenus¹

The shell is generally imperforate, though most of the species have an umbilical depression. The sculpture consists of numerous beaded cords which may cover the entire surface or be formed only at the whorl periphery or above the base.

Radula with 5 to 7 nearly uniform lateral teeth, the first and second marginal teeth rather long and not too dissimilar to the remaining marginal teeth. Outermost marginal teeth non-serrated (see Plate 6, figs. 1-3 and Plate 7, figs. 1-4).

Jaws rounded, the anterior ends rather broadly rounded and having a very short edge of fringe along the anterior margin (see Plates 10 and 11).

Type species, *Calliostoma bairdii* Verrill and Smith.

¹ From the Greek, meaning a string of beads, in reference to the beaded cords.

Calliostoma (Kombologion) bairdii *Verrill and Smith*

Plate 6, fig. 1; Plate 10, fig. 1; Plate 24

Calliostoma bairdii Verrill and Smith 1880, American Journal Science **20**: 396 (*Fish Hawk*, stations 865 to 880, about 150 to 200 miles east of Barnegat Bay, New Jersey in 65 to 252 fathoms); Verrill 1882, Trans. Connecticut Academy of Sciences **5**: 580, pl. 57, fig. 26.

Description. Shell reaching 31.5 mm. (about $1\frac{1}{4}$ inches) in length, trochoid in shape, solid in structure, imperforate and rather coarsely sculptured. Color a light brownish yellow with occasional irregular and rather faint blotches of reddish brown. Whorls $7\frac{1}{2}$ to 8, flat sided with a pronounced keel at the whorl periphery. Spire moderately extended and produced at an angle of about 70° . Aperture subquadrate, outer lip simple and produced at an angle of about 30° from the base. Columella slightly arched and truncated at the base. Umbilical area smooth and somewhat iridescent. Suture very indistinct. Sculpture consisting of 6 to 7 cords on the body whorl above the periphery, the one at the periphery being the strongest. Below the periphery there are 10 to 15 cords which vary in both size and extent of beading. Operculum nearly circular, thin, corneous, multispiral and light brown in color. Periostracum very thin, light golden brown in color. Nuclear whorls $1\frac{1}{2}$, small, white and smooth.

In *C. bairdii* the foot is ivory colored, marked with streaks of red-brown with light diffused patches of the same color on either side and on top of the head. The mantle is a uniform ivory with small flame-like patches of brownish orange along the edge on the muscular rim. There are irregular patches of opaque white spots on the mantle of most specimens examined.

length	width	
30 mm.	31 mm.	Lectotype
27.5	28	140 miles E of Seagirt, New Jersey
31.5	31	215 miles E of Seagirt, New Jersey
30.5	33	225 miles E of Barnegat Bay, New Jersey

Types. The lectotype, here selected, is from the *Fish Hawk*, station 874, about 150 miles E of Barnegat Bay, New Jersey ($40^\circ 00' N$; $70^\circ 57' W$) in 85 fathoms and is in the United States National Museum, no. 44722. Paratypes from *Fish Hawk*, stations 867, 871, 872, 873, and 877 are also in the United States National Museum. Paratypes from *Fish Hawk* stations 867, 871 and 873 are in the Peabody Museum, Yale University. Paratypes from station 871 are in the Academy of Natural Sciences Philadelphia and from station 874 are in the Museum of Comparative Zoology.

Remarks. This species differs from *C. psyche* Dall by being larger, having a narrower angle to the spire and lacking the luster of *psyche*. In addition, it is more coarsely sculptured than *psyche* and there appears to be much less red mottling.

The ranges of the two species overlap in the area between Cape Hatteras and Cape Lookout, North Carolina, but we have seen no intermediate specimens.

Range. From off Chatham, Massachusetts ($41^\circ 40' N$) south to off Cape Lookout, North Carolina ($34^\circ 39' N$) in depths from 43 to 254 fathoms.

Specimens examined. MASSACHUSETTS: *Albatross*, station 2526, about 205 miles E of Chatham ($41^\circ 40' N$; $65^\circ 46' W$) in 121 fathoms (MCZ). NEW JERSEY: *Blake*, station

145, about 140 miles E of Seagirt ($40^{\circ}10' N$; $71^{\circ}04' W$) in 71 fathoms (MCZ); *Fish Hawk*, station 867, about 175 miles E of Barnegat Bay ($40^{\circ}05' N$; $70^{\circ}22' W$) in 64 fathoms (USNM; Yale); *Fish Hawk*, station 871, about 170 miles E of Barnegat Bay ($40^{\circ}02' N$; $70^{\circ}23' W$) in 115 fathoms (USNM; Yale; ANSP); *Fish Hawk*, station 873, about 150 miles E of Barnegat Bay ($40^{\circ}02' N$; $70^{\circ}57' W$) in 100 fathoms (USNM; Yale); *Fish Hawk*, station 941, about 200 miles E of Barnegat Bay ($40^{\circ}01' N$; $69^{\circ}56' W$) in 79 fathoms (MCZ; USNM; Yale; ANSP); *Fish Hawk*, station 874, about 150 miles E of Barnegat Bay ($40^{\circ}00' N$; $70^{\circ}57' W$) in 85 fathoms; *Fish Hawk*, station 877, about 155 miles E of Barnegat Bay ($39^{\circ}56' N$; $70^{\circ}54' W$) in 126 fathoms (both USNM); *Fish Hawk*, station 939, about 235 miles E of Barnegat Bay ($39^{\circ}53' N$; $69^{\circ}50' W$) in 264 fathoms (USNM); *Albatross III*, station 34, about 340 miles E of Barnegat Bay ($40^{\circ}27' N$; $68^{\circ}00' W$) in 77 fathoms; *Albatross II*, station 20399, about 100 miles E of Atlantic City ($39^{\circ}23' N$; $72^{\circ}18' W$) in 88 fathoms (both MCZ); *Albatross*, station 2591, about 100 miles E of Cape May ($38^{\circ}53' N$; $72^{\circ}52' W$) in 188 fathoms (Yale). MARYLAND: *Fish Hawk*, station 1047, about 85 miles E of Ocean City ($38^{\circ}31' N$; $73^{\circ}21' W$) (USNM; Yale). VIRGINIA: *Bill II*, station 146, about 75 miles E of Chincoteague Island ($38^{\circ}33' N$; $73^{\circ}18' W$) in 63–65 fathoms; *Albatross*, station 2021, about 70 miles E of Metumken Inlet ($37^{\circ}36' N$; $74^{\circ}15' W$) in 179 fathoms (both MCZ); *Fish Hawk*, station 896, about 65 miles E of Great Machpongo Inlet ($37^{\circ}26' N$; $74^{\circ}19' W$) in 56 fathoms (Yale). NORTH CAROLINA: *Albatross*, station 2307, about 45 miles NE of Cape Hatteras ($35^{\circ}42' N$; $74^{\circ}54' W$) in 43 fathoms; *Albatross*, station 2592, about 25 miles SE of Cape Hatteras ($35^{\circ}02' N$; $75^{\circ}12' W$) in 120 fathoms; *Albatross*, station 2600, about 50 miles E of Cape Lookout ($34^{\circ}39' N$; $75^{\circ}35' W$) in 85 fathoms (all MCZ); *Albatross*, station 2601, about 53 miles E of Cape Lookout ($34^{\circ}39' N$; $75^{\circ}33' W$) in 107 fathoms (MCZ).



Plate 24. *Calliostoma bairdii* Verrill and Smith. Fig. 1. *Fish Hawk*, station 874, about 150 miles E of Barnegat Bay, New Jersey ($40^{\circ}00' N$; $70^{\circ}57' W$) in 85 fathoms. Lectotype. Fig. 2. Paratype from the same locality (both 2x).

Calliostoma (Kombologion) *psyche* Dall

Plate 7, fig. 1; Plate 25

Calliostoma psyche Dall 1878, Bulletin Museum Comparative Zoology 5: 61 [nomen nudum]; Dall 1880, Bulletin Museum Comparative Zoology 6: 45 [nomen nudum].

Calliostoma bairdii psyche Dall 1889, Bulletin Museum Comparative Zoology **18**: 364 (off Florida Reefs in 100–200 fathoms, Pourtales collector).

Description. Shell reaching 20.5 mm. (about $\frac{3}{4}$ inch) in length, trochoid in shape, relatively thin but strong, imperforate and moderately sculptured. Color a light golden yellow marbled with irregular patches of brownish red. Base with 5 to 8 brownish yellow lines alternating with the beaded cords which are white. Whorls 8, flat sided with a pronounced keel at the whorl periphery. Spire moderately extended, usually slightly concave and produced at an angle of about 75° . Aperture subquadrate, outer lip simple and produced at an angle of about 35° from the base. Columella arched and usually truncated at the base. Umbilical area margined by a smooth ridge, white to iridescent. Nearly all specimens have a slight depression in the umbilical area and in occasional specimens it may be quite deep. Sutures indistinct. Sculpture consisting of 7 to 8 beaded cords including the two at the periphery of the whorl with 12 to 15 beaded cords on the base. The spaces between the spiral cords are usually a shiny yellow-brown in color. Operculum circular, thin, corneous, multispiral and colored a light yellowish brown. Periostracum very thin, golden brown. Nuclear whorls small, $1\frac{1}{2}$, white and shiny.



Plate 25. *Calliostoma psyche* Dall. Fig. 1. Off the Florida Reefs in 100–200 fathoms. Lectotype. Figs. 2–4. Off Palm Beach, Florida (both 1.9x).

length	width	
20.5 mm.	24 mm.	off Palm Beach, Fla., 115 fathoms
20	24	SW Egmont Key, Fla., 100 fathoms
16.5	19.3	Lectotype

Types. The lectotype of *C. psyche*, here selected, is in the Museum of Comparative Zoology, no. 224572 from off the Florida Reefs in 100–120 fathoms, collected by Count Pourtales.

Remarks. See under *C. bairdii* V. & S.

Range. From off Cape Hatteras, North Carolina south through the Florida Keys and on the west coast of Florida off Tarpon Springs; in depths from 14 to 200 fathoms.

Specimens examined. NORTH CAROLINA: *Combat*, station 70, about 23 miles ESE of Cape Hatteras, (35°07' N; 75°04' W) in 190 fathoms (H. Bullis); *Albatross*, station 2603, 49 miles E of Cape Lookout (34°38' N; 75°33' W) in 124 fathoms; *Albatross*, station 2614, 36 miles SE of Cape Lookout (34°09' N; 76°02' W) in 168 fathoms (both USNM). GEORGIA: *Pelican*, station 179, 109 miles ESE of Altamaha Id., McIntosh Co. in 45 fathoms; *Pelican*, station 197, 85 miles ENE of St. Andrews Id., Camden Co. in 50–100 fathoms (both USNM). FLORIDA: SE of Fernandina, in 200 fathoms (T. McGinty); *Combat*, station 79, about 70 miles E of St. Augustine (30°00' N; 80°14' W) in 110 fathoms; *Combat*, station 91, 60 miles E of Daytona (28°50' N; 80°04' W) in 80 fathoms (both H. Bullis); *Pelican*, station 205, 38 miles E of Melbourne, Brevard Co. in 70–95 fathoms (USNM); off Palm Beach in 80–115 fathoms (T. McGinty; MCZ; ANSP; H. & K. Johnstone); off Lantana in 100 fathoms (T. McGinty; MCZ; ANSP); off Boynton Beach, 105–115 fathoms (T. McGinty; MCZ); off Yamato Rocks (UMML); off Delray Beach in 85 fathoms (T. McGinty); off Boca Raton in 14 fathoms; off Hillsboro in 30–70 fathoms (both J. A. Weber); off Fort Lauderdale in 90 fathoms (T. McGinty); off Miami Beach in 100 fathoms (J. A. Weber; H. & K. Johnstone); *Albatross*, station 2648 off Cape Florida (25°53' N; 80°03' W) in 84 fathoms (USNM); off Fowey Light in 47–130 fathoms (USNM; MCZ); *Eolis*, Triumph Reef in 70–80 fathoms; *Eolis*, Ajax Reef in 70–100 fathoms (dead); *Eolis*, Caesar Creek, Elliott Key in 90 fathoms (all USNM); off Carysfort Light, Key Largo in 70 fathoms (T. McGinty); *Albatross*, station 2641 off Carysfort Light (25°11' N; 80°10' W) in 60 fathoms (USNM); off Key Largo in 125 fathoms (J. A. Weber); off Sombrero Key in 110 fathoms (MCZ; ANSP; T. McGinty); off American Shoals in 100 fathoms; Pelican Shoals (both J. A. Weber); *Eolis*, off Sambo Reef in 118–120 fathoms (USNM); off Key West (UMML); off Sand Key in 69–134 fathoms (MCZ; USNM); *Eolis*, off Western Dry Rocks in 90 fathoms (USNM); *Oregon*, station 1392, 120 miles E of Tarpon Springs (28°11' N; 85°07' W) in 107 fathoms (H. Bullis); SW of Egmont Key in 100 fathoms (D. Steger).

***Calliostoma (Kombologion) rosewateri*, new species¹**

Plate 6, fig. 3; Plate 10, fig. 2; Plate 26

Description. Shell reaching 32 mm. (about 1¼ inches) in length, trochoid in shape, thin in structure, imperforate and rather coarsely sculptured. Color an iridescent golden yellow, often with an iridescent green on the early whorls and with more or less regular patches of reddish brown. The base may be without color or with as many as 5 or 6 spiral lines of red-brown which may be entire or broken. Whorls 10, nearly flat sided and with a keel at the whorl periphery. Spire moderately extended, slightly concave and produced at an angle of about 80°. Aperture subquadrate, outer lip simple and produced at an angle of about 45° from the base. Columella strongly arched and truncated at the base. Umbilical area deep and iridescent. Suture indistinct. Sculpture consisting of 12 or 13 beaded cords on the body whorl, the third cord above the periphery being the strongest. Sculpture below the periphery variable. The surface may be smooth or may be sculptured with numerous fine, slightly beaded cords. Operculum nearly circular, thin, corne-

¹ Named for Dr. Joseph Rosewater, student and colleague, now in the Division of Mollusks, United States National Museum.

ous, multispiral and light brown in color. Periostracum very thin and iridescent. Nuclear whorls $1\frac{1}{2}$, white, smooth and very small.

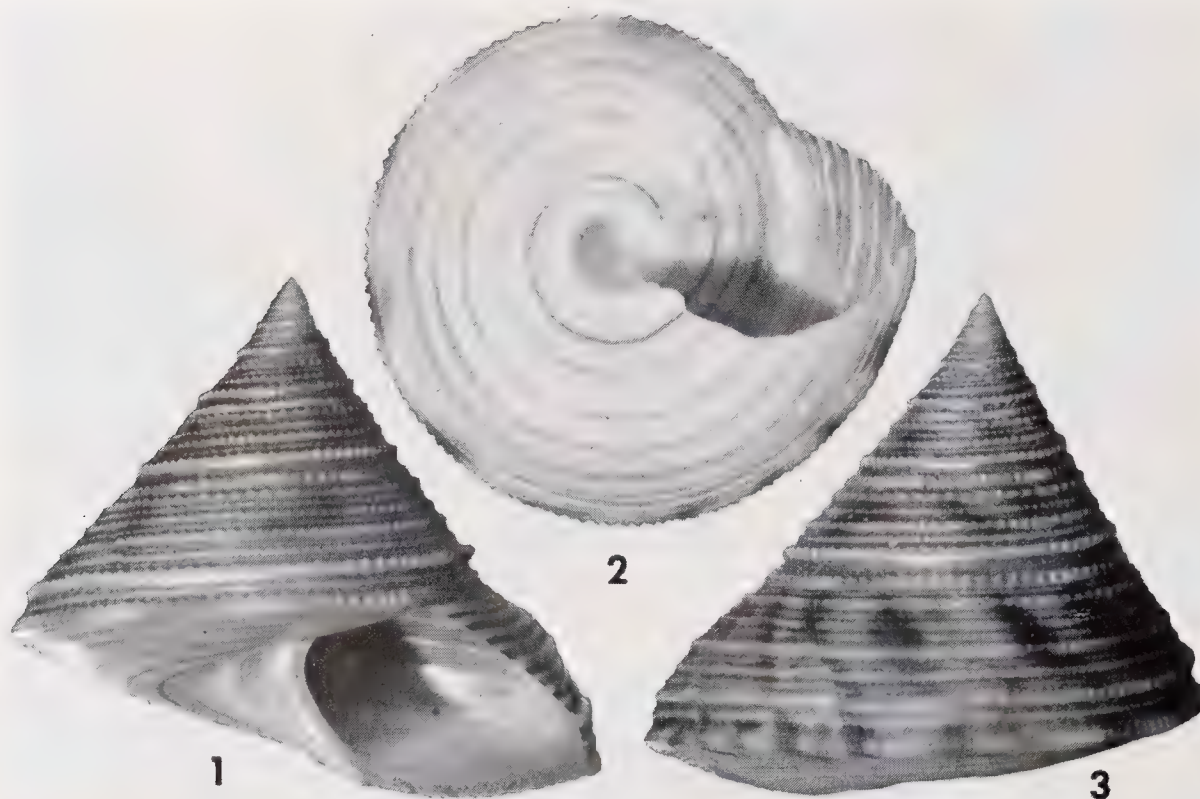


Plate 26. *Calliostoma rosewateri* Clench and Turner. Fig. 1. *Oregon*, station 1985, about 85 miles SE of Galeota Point, Trinidad. Holotype. Fig. 2 and 3. Paratypes from the same locality (all 4x).

length	width	
28 mm.	34 mm.	Holotype
32	37	60 miles E of Galeota Pt., Trinidad
27	34	85 miles SE of Galeota Pt., Trinidad

Types. The holotype is in the United States National Museum, no. 612704 from the *Oregon*, station 1985, about 85 miles SE of Galeota Point, Trinidad ($09^{\circ}04' N$; $59^{\circ}47' W$) in 150 fathoms. Paratypes from the same locality and from *Oregon*, station 1981, about 60 miles E of Galeota Point, Trinidad ($10^{\circ}03' N$; $60^{\circ}01' W$) in 200 fathoms and *Oregon*, station 1989, about 90 miles SE of Galeota Point, Trinidad ($09^{\circ}45' N$; $59^{\circ}45' W$) in 175 fathoms, are in the collection of H. Bullis.

Remarks. *Calliostoma rosewateri* is close in its relationship to *C. oregon* but is much larger, proportionately broader and has a nearly smooth base. Both species are highly colored and have a golden coloration not nearly so well developed in other species in the subgenus *Kombologion*.

Range and Specimens examined. See under *Types*.

***Calliostoma (Kombologion) oregon*, new species¹**

Plate 2; Plate 6, fig. 2; Plate 27

Description. Shell reaching 20 mm. (about $\frac{3}{4}$ inch) in length, trochoid in shape, rather thin in structure, perforate or imperforate and highly sculptured. Color a golden red with

¹ Named for the M/V *Oregon*, research vessel of the U.S. Fish and Wildlife Service.

the spiral cords white. Whorls 8, flat sided, with an acute keel and produced at an angle of about 70° . Spire moderately extended and slightly concave. Aperture subquadrate and produced at an angle of 55° from the base. Outer lip simple and thin. Columella thickened, arched but not truncate. Umbilicus narrow, partially or completely closed by a thin umbilical pad. Suture indistinct. Sculpture consists of 7 subequal beaded cords above the periphery. Below the periphery the cords vary in width, become somewhat flattened and the beading becomes less distinct except on the two cords at the umbilical area. Nuclear whorl white and smooth. Operculum circular, multispiral, corneous and with a papilliform nucleus.

Animal (preserved specimen) with the foot heavily streaked and reticulated with red-brown on a ground color of ivory with fine streaks of the same color on the side of the bead below the eye and across the top. Tentacles with two to four streaks of red-brown, extending the entire length. Mantle very thin, the muscular edge thin and not colored.

length	width	
20 mm.	21 mm.	Holotype
17	19	Paratype
16	18	Paratype

Types. The holotype is in the United States National Museum, no. 612705, from the *Oregon*, station 550, about 70 miles SE of Corpus Christi, Texas ($26^\circ 55'$ N; $96^\circ 25'$ W) in 125 fathoms.

Remarks. See under *C. rosewateri*.



Plate 27. *Calliostoma oregon* Clench and Turner. *Oregon*, station 550, about 70 miles SE of Corpus Christi, Texas in 125 fathoms. Fig. 1. Holotype. Fig. 2. Paratype (both about 2.3x).

Specimens examined. FLORIDA: *Silver Bay*, station 157, about 50 miles SW of Cape San Blas ($29^\circ 12'$ N; $86^\circ 06'$ W) in 116 fathoms; *Oregon*, station 947, about 70 miles SSE of Pensacola ($29^\circ 30'$ N; $86^\circ 56'$ W) in 190 fathoms (both H. Bullis). TEXAS: *Oregon*, station 550, about 70 miles SE of Corpus Christi ($26^\circ 55'$ N; $96^\circ 25'$ W) in 125 fathoms (USNM).

***Calliostoma (Kombologion) hendersoni* Dall**

Plate 7, fig. 4; Plate 11, fig. 2; Plate 28

Calliostoma hendersoni Dall 1927, Proc. United States National Museum 70: 7 (off Sambo Reefs, Florida in 118 fathoms).

Description. Shell reaching 19.5 mm. (about $\frac{3}{4}$ inch) in length, trochoid in shape, solid in structure, umbilicate and rather coarsely sculptured. Beaded cords above the periphery a glistening ivory, the spaces between the cords a golden brown. The peripheral keel consists of two cords without interspaces which are regularly mottled with patches of deep pink. Below the periphery the cords are smooth; they may be single or grouped in pairs, the interspaces being a golden brown. Whorls 8, generally flat sided, and with a sharp keel. Base flat to slightly convex. Spire moderately extended, slightly concave, produced at an angle of about 75° . Aperture subquadrate, the outer lip simple and produced at an angle of about 35° from the base. Columella iridescent, arched inwardly and truncate. Umbilicus relatively narrow and profound. It is margined by a rather large and coarsely beaded cord. Suture relatively indistinct, indicated by the peripheral cord. Sculpture consists of 6 beaded cords above the periphery; below the periphery cords are usually paired, flattened and smooth. Operculum circular, corneous, thin, multispiral, with a central nucleus. Nuclear whorls $1\frac{1}{2}$, smooth and white in color.

Animal ivory-white streaked with red-brown. The base of the foot a uniform ivory. Mantle streaked with red-brown. Eyes black.

length	width	
19.5 mm.	23 mm.	Holotype
17	19.5	off Cay Sal Bank, Bahama Ids.
16.5	19	" " " " " "

Types. The holotype is in the United States National Museum, no. 333703, from *Eolis*, station 331 from off Sambo Reef, Florida in 118 fathoms [about 8 miles SE of Key West, Florida].

Remarks. *Calliostoma hendersoni* is closely related to *C. oregon*, differing by being less coarsely sculptured and having the cords on the base smooth rather than beaded. In addition, the umbilicus is always present and is wider than that found in some specimens of *C. oregon*.

Range. Known only from the two localities in the Straits of Florida.

Specimens examined. FLORIDA: off Sambo Reef, about 8 miles SE of Key West in 118 fathoms (USNM). BAHAMA ISLANDS: *Oregon*, station 1349, about 8 miles NE of Cay Sal Bank (H. Bullis).

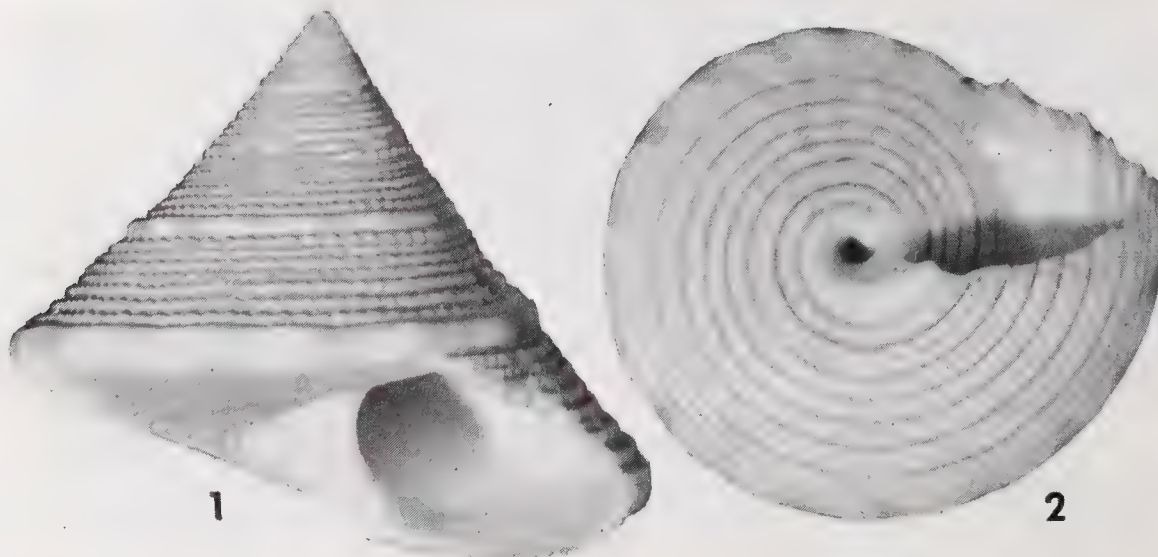


Plate 28. *Calliostoma hendersoni* Dall. Fig. 1. *Eolis*, station 321, off Sambo Reef, Florida in 118 fathoms. Holotype. Fig. 2. *Oregon*, station 1349, off Cay Sal Bank, Bahama Islands in 150 fathoms (both 2.8x).

Calliostoma (Kombologion) schroederi *Clench and Aguayo*

Plate 7, fig. 2; Plate 11, fig. 1; Plate 29

Calliostoma (Calliostoma) schroederi Clench and Aguayo 1938, *Memorias de la Sociedad de Historia Natural* 12: 377, pl. 28, fig. 3 (*Atlantis*, station 2981, off Punta Alegre, Camagüey, Cuba ($22^{\circ}48' N$; $78^{\circ}48' W$) in 225 fathoms).



Plate 29. *Calliostoma schroederi* Clench and Aguayo. Fig. 1. *Atlantis*, station 3409, off Punta Alegre, Camagüey, Cuba in 200 fathoms (2.6x). Fig. 2. *Combat*, station 235, off Mantanilla Shoals, Little Bahama Bank, Bahama Islands (2.6x) Fig. 3. *Atlantis*, station 2981, off Punta Alegre, Camagüey, Cuba in 225 fathoms. Holotype (2.2x).

Description. Shell reaching 29 mm. (about $1\frac{1}{8}$ inches) in length, trochoid in shape, fairly solid in structure, imperforate and sculptured. Color a uniform ivory-white with 4 to 5 thread-like bands of yellow above and below the periphery. Entire shell highly opalescent. Whorls 8 to 9, nearly flat-sided, with a very pronounced peripheral keel. Spire somewhat extended, slightly concave and produced at an angle of about 70° . Aperture subquadrate; the outer lip simple and produced at an angle of about 65° from the base. Columella arched inwardly and slightly truncated at the base in adults. Suture very indistinct. Sculpture consisting of two high, beaded peripheral cords with a much finer and lower cord between them on the body whorl of adult specimens. Above the periphery there are numerous fine, smooth, spiral threads. Base of the shell smooth other than a few fine spiral threads around the columella area. Axial sculpture consists of numerous fine oblique growth lines. The first 3 to 5 post-embryonic whorls often have a reticulated sculpture. The axial riblets disappear beyond the fifth whorl. Nuclear whorl very small, white, opaque and smooth. Operculum thin, multispiral and corneous, sculptured with exceedingly fine radiating threads.

The soft parts of preserved specimens of *C. schroederi* are a uniform ivory color with

no indication of color markings. The foot appears to be proportionately much smaller than in other species of *Calliostoma* and is smooth, while in other species examined it is usually papillose.

length	width	
25 mm.	25 mm.	Holotype
29	31	off Punta Alegre, Camagüey, Cuba
26	28	“ “ “ “ “

Types. The holotype of *C. schroederi* Clench and Aguayo is in the Museum of Comparative Zoology, no. 135002. The type locality is *Atlantis*, station 2981, off Punta Alegre, Camagüey, Cuba (22°48' N; 78°48' W) in 225 fathoms. Three paratypes from the same station are in the Museum of Comparative Zoology and the Museo Poey, Habana, Cuba. A single paratype from *Atlantis*, station 2999A from off Matanzas, Cuba (23°10' N; 81°29' W) in 145 fathoms is in the Museum of Comparative Zoology, no. 135149.

Remarks. This beautiful *Calliostoma* is characterized by its high pearly opalescence and its double peripheral carina. On the basis of its jaws and radula this species is placed in the subgenus *Kombologion*. In appearance it most closely resembles *C. atlantis* Clench and Aguayo.

Range. Northern Bahamas south to Camagüey, Cuba.

Specimens examined. BAHAMA ISLANDS: *Combat*, station 235, off Mantanilla Shoals, Little Bahama Bank (27°27' N; 78°58' W) in 180 fathoms (H. Bullis). CUBA: *Atlantis*, station 2999A, off Matanzas (23°10' N; 81°29' W) in 145–190 fathoms; *Atlantis*, station 3415, off Punta Alegre, Camagüey (22°51' N; 78°55' W) in 210 fathoms; *Atlantis*, station 3414, off Punta Alegre, Camagüey (22°50' N; 78°52' W) in 230 fathoms; *Atlantis*, station 2981, off Punta Alegre, Camagüey (22°48' N; 78°48' W) in 225 fathoms; *Atlantis*, station 3409, off Punta Alegre, Camagüey (22°44' N; 78°41' W) in 200 fathoms; *Atlantis*, station 3404, off Cayo Coco, Camagüey (22°37' N; 78°23' W) in 215 fathoms (all MCZ).

***Calliostoma* (Kombologion) adpersum Philippi**

Plates 30 and 31

Trochus eximius 'Reeve' Philippi 1844, *Abbildungen Neuer Conchylien* 1: pt. 6, p. 17 (pt. 39 of volume), pl. 4, fig. 7 (no locality given) non *T. eximius* Reeve 1842 [1843].

Trochus adpersus 'Beck' Philippi 1851, *Conchylien Cabinet* (2) 2: pt. 3, p. 217, pl. 32, fig. 8 (Brazil).

Calliostoma depictum Dall 1927, *Proc. United States National Museum* 70: 6 (Bahia, Brazil).

Calliostoma aspersum 'Philippi' Lange de Morretes 1949, *Acquívios do Museu Paranense* 7: pt. 1, p. 58 [non *C. aspersum* Philippi 1846].

Description. Shell reaching 20.5 mm. (about $\frac{3}{4}$ inch) in length, depressed trochoid in shape, solid in structure, imperforate and rather finely sculptured. Color ivory, with large, irregular blotches of brownish red which are more or less axially aligned. Base of whorl with irregularly spaced, fine, reddish brown color spots on the cords. Whorls 8, flat sided, with a pronounced flattened keel at the whorl periphery. Spire moderately extended and produced at an angle of about 65°. Aperture subquadrate, outer lip simple

and produced at an angle of about 45° from the base. Columella arched and truncate at the base. Umbilical area iridescent, with a lengthened depression to the left of the columella. Suture indistinct. Sculpture consists of numerous, large and small, finely beaded cords above the periphery. Below the periphery the cords are smooth or nearly so, the cord at the umbilical area being much larger and smooth. The flattened keel consists of two large marginal cords and two inner smaller cords. Operculum circular, thin, corneous, multispiral and light golden brown in color. Nuclear whorls 1½, small, white and smooth. Periostracum exceedingly thin and inconspicuous.

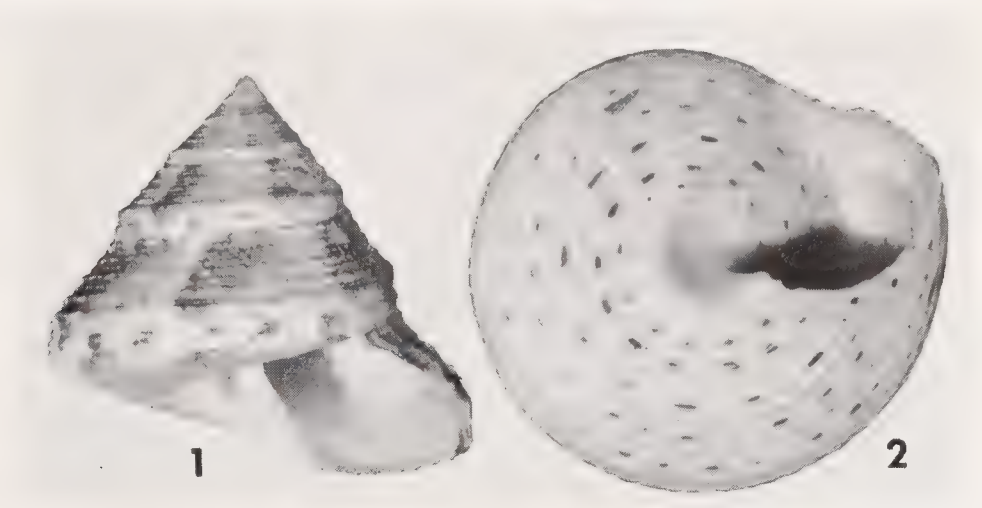


Plate 30. *Calliostoma adpersum* Philippi. Fig. 1. Praia do Leste, Ilha Guaiba, Rio de Janeiro, Brasil. Fig. 2. Basal view of a specimen from the same locality (both 2.4x).

length	width	
20 mm.	21.5 mm.	São Paulo, Brasil
17	19	Ilha Guaiha, Rio de Janeiro, Brasil
10	10.6	Holotype of <i>C. depictum</i> Dall

Types. The holotype of *Trochus adpersus* ‘Beck’ Philippi is probably in the Berlin Museum. The type locality which was given only as Brasil, is here restricted to Praia do Leste, Ilha Guaiba, Estado de Rio de Janeiro, a locality from which we have had living



Plate 31. *Calliostoma depictum* Dall (= *adpersum* Phil.), Bahia [Baia], Brasil. Holotype (6x).

material. The holotype of *Calliostoma depictum* Dall is in the United States National Museum, no. 152667, from Bahia [Baia], Brasil.

Remarks. This species appears to be related to *C. yucatecanum* Dall but differs by being imperforate, in lacking the exceedingly fine spiral threads between the cords and in having the spiral cords on the body whorl of adult specimens beaded rather than smooth.

The radula and jaws of *adpersum* place it in the subgenus *Kombologion*.

So far as we know this is a littoral species, occurring just below the low tide line. It is apparently rather rare to judge by the few lots available for study.

Calliostoma depictum Dall was based on a young specimen of *adpersum*.

Range. From Salvador, Estado Baia and probably south as far as Florianopolis, Estado Catarina, Brasil.

Specimens examined. BRASIL: Salvador, Est. Baia (USNM); Praia do Leste, Ilha Guaiba, Est. Rio de Janeiro (de Oliveira; Lopez); Santos, Est. São Paulo (SU); Villa Bella, Ilha de São Sebastião, Est. São Paulo (P. de Oliveira; USNM).

Calliostoma (Kombologion) euglyptum A. Adams

Plate 32, figs. 1–2

Zizyphinus euglyptus A. Adams 1854 [1855], Proceedings Zoological Society London, p. 38 (Van Diemen's Land [Tasmania]); Reeve 1863, Conchologia Iconica 14: *Zizyphinus*, pl. 3, fig. 17.

Calliostoma euglyptum A. Adams. Dall 1889, Bulletin Museum Comparative Zoology 18: 363; Pilsbry 1889, Manual of Conchology (1) 11: 374, pl. 15, fig. 37, pl. 57, fig. 9.

Description. Shell reaching 25 mm. (1 inch) in length, turbate, solid in structure, rather coarsely sculptured and imperforate. Color a pinkish brown, often mottled with white. The apical whorls often a dark purplish brown as a result of the wearing away of the prismatic layer to expose the surface beneath. Whorls $7\frac{1}{2}$, slightly convex and with a rounded keel. Base of shell flat to slightly convex. Spire somewhat extended and produced at an angle of about 70° . Aperture subquadrate, the outer lip simple and produced at an angle of about 40° from the base. Columella is arched, thickened and white; suture indented, but relatively obscure. Sculpture consists of numerous rather fine beaded cords. The sculpture is somewhat variable and on some areas of the shell these cords may vary in size, alternating with finer cords interspersed with the more normal ones. On the early whorls the cords appear about equal in size. There are about 12 cords on the base of the shell. Nuclear whorls $1\frac{1}{2}$, minute, opaque white and smooth; first two post nuclear whorls with two beaded cords and faintly axially costate. Operculum thin, corneous, circular, multispiral and a light golden brown in color.

Jaws narrowly rounded anteriorly and with long tufts of scales. The radula is similar to that shown for *bullisi* and *juchubinum* differing in having seven marginals, the outermost having very long, thread-like cusps on a large somewhat triangular base.

length	width	
20 mm.	20 mm.	Egmont Key, Tampa Bay, Florida
16.5	18	Hillsboro, Florida
25	26	Marco Island, Florida

Types. The holotype of *Z. euglyptum* A. Adams described from the Cuming collection is probably in the British Museum (Natural History). The type locality Tasmania, as originally given by A. Adams, was in error. We here restrict the type locality to Tampa Bay, Florida, as this is a possible locality from which Cuming could have received material at that early date.

Remarks. On the basis of shell characters *C. euglyptum* does not appear to be closely related to other species in the subgenus *Kombologion*. In general, comparison can be made with *C. adpersum* Philippi. *Calliostoma euglyptum* differs by having the periphery of the whorl rounded rather than somewhat flattened. In addition, *euglyptum* has beaded cords on the base of the shell while in *adpersum* the cords are smooth or finely sculptured by growth lines. There is a somewhat similar pattern of flame-like color marks on both species though it is more intense in *adpersum*.

The ranges of the two species are widely separated.

Calliostoma euglyptum is found from low water to depths of at least 32 fathoms.

Range. Continental North America from Cape Hatteras, North Carolina south on the east coast of Florida to Hillsboro Inlet, and west Florida from Marco north to off Destin and on the Campeche Banks, Mexico.

Specimens examined. NORTH CAROLINA: *Albatross*, station 2605, 41 miles off Cape Hatteras (34°35' N; 75°34' W) in 32 fathoms (USNM); Breakwater, Fort Macon (T. A. Stephenson); Piver's Island, Beaufort (MCZ); 11 miles SSW of Beaufort in 9 fathoms; Black Rocks, New River; *Pelican*, station 183, 21 miles SW of Cape Fear, Hanover County, in 9 fathoms; 44 miles SSW of Cape Fear (all USNM). SOUTH CAROLINA: Ocean Drive Beach (R. E. Petit); 47 miles ESE of Bulls Island, Charleston Co. in 17 fathoms (USNM). GEORGIA: *Pelican*, station 180-5, about 20 miles SE of mouth of Savannah River (31°53' N; 80°34' W) in 8 fathoms; *Pelican*, station 180-4, about 25 miles SE of the mouth of the Savannah River (31°52' N; 80°29' W) in 9 fathoms; *Pelican*, station 196-2, about 38 miles SE of mouth of Savannah River (31°41' N; 80°24' W) in 12 fathoms (all USNM). FLORIDA: St. Augustine; *Pelican*, station 172-3,

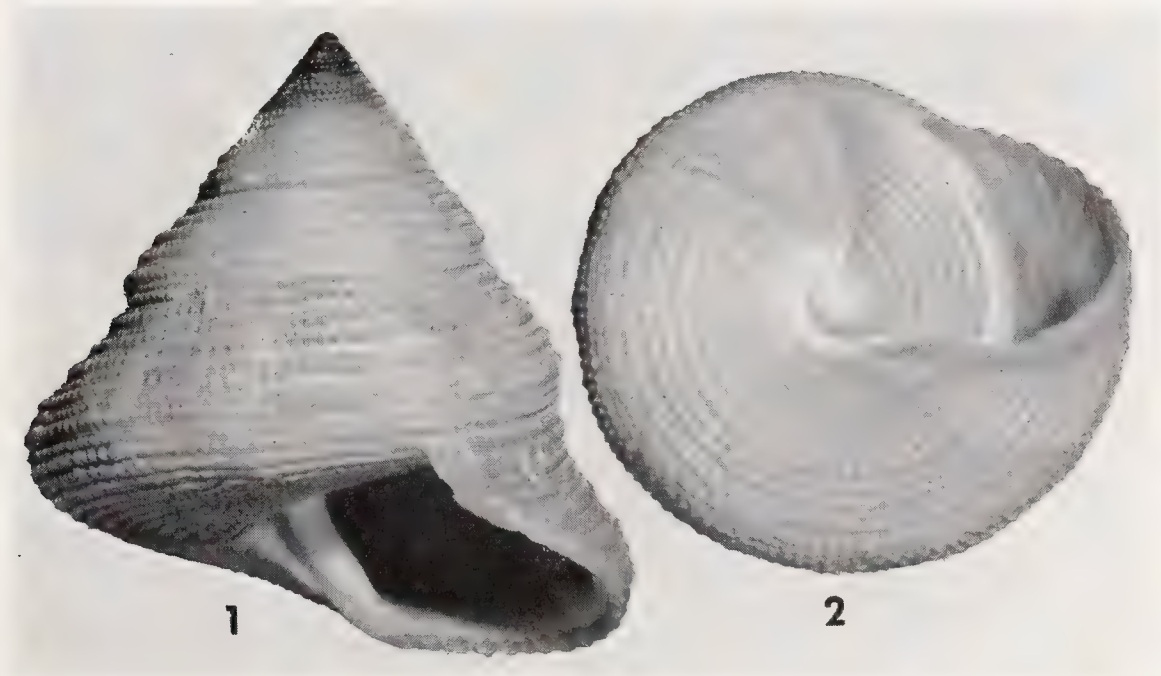


Plate 32. *Calliostoma euglyptum* A. Adams. Marco Island, Florida (2.6x).

about 17 miles E of Daytona Beach (29°11' N; 80°43' W) in 12 fathoms (both USNM); Daytona (MCZ); Coco Beach (G. & M. Kline); Vero Beach (H. & K. Johnstone); Fort Pierce, Hutchinson Island (D. & N. Schmidt); Jupiter Inlet (USNM); Lake Worth Inlet (UMML); Palm Beach (F. Bayer; ANSP); Boynton Beach (T. McGinty); Hillsboro (D. Moore); off Destin in 14 fathoms (T. McGinty); Cedar Keys (UMML); off Tarpon Springs (J. S. Schwengel; ANSP); off Clearwater (7–10 fathoms) (S. Kaicher); SSW of Johns Pass, St. Petersburg in 29 fathoms (D. & B. Steger); Egmont Key, Tampa Bay (MCZ); Anna Maria Key, Sarasota (USNM); Bradenton Beach (D. & N. Schmidt; A. Koto); Long Boat Key, Sarasota (Mrs. Leo Chambers; USNM); Casey Key, Sarasota Co. (Carnegie Mus.); SW of Big Pass, Sarasota Co. (7–8 fathoms) (MCZ); Midnight Pass, Sarasota (D. & N. Schmidt); Gasparilla Island (ANSP); off Sanibel Island in 6 fathoms (J. S. Schwengel; ANSP); Bonita Springs (USNM); Marco Island (D. Steger; ANSP). MEXICO: Veracruz (USNM); Campeche Banks, Yucatan in 15 fathoms (T. McGinty).

Calliostoma (Kombologion) marionae Dall

Plate 7, fig. 3; Plate 33

Calliostoma marionae Dall 1906, *Nautilus* **19**: 131 (off Fowey Rocks [Miami] Florida).

Calliostoma (Eutrochus) faustum Schwengel and McGinty 1942, *Nautilus* **56**: 14, pl. 6, fig. 1 (Lake Worth, Florida in 80 fathoms).

Description. Shell reaching 29 mm. (about $1\frac{1}{8}$ inches) in length, trochoid in shape, moderately solid in structure, perforate and finely sculptured. Color a nearly uniform brown or pinkish brown with most specimens mottled with small patches of white. Whorls 10, slightly convex and with a keel on the whorl periphery. Spire extended and produced at an angle of 65°. Aperture subquadrate, outer lip simple and produced at an angle of about 27° from the base. Columella arched and truncated at the base. Umbilicus deep and margined with a strong cord. Suture distinct. Sculpture consists of 5 or 6 finely beaded cords on the first 4 whorls following the nuclear whorls. On the fifth whorl, these beads disappear and the shell becomes smooth other than for 4 or 5 fine, incised lines. On the base there are 12 to 14 incised lines, the 3 nearest the umbilicus separating three rather indistinct and irregular cords. Operculum nearly circular, thin, corneous, multi-spiral and light golden brown in color. Nuclear whorls white, the first whorl smooth, the second whorl beaded. Foot ivory colored with fine reticulated markings of a medium red-brown and streaks of a dark red-brown. Sole of foot a uniform ivory. The head is a uniform red-brown anteriorly, becoming mottled posteriorly. Tentacles mottled red-brown, eye stalk short, streaked with red-brown. Eyes black. Mantle ivory, the edge having more or less uniform squarish dots of red-brown.

length	width	
20.5 mm.	18 mm.	Holotype of <i>C. marionae</i>
8	7.5	Holotype of <i>C. faustum</i>
25	23	50 miles E of St. Augustine, Florida
29	27.5	126 miles W of Cedar Keys, Florida

Types. The holotype of *C. marionae* Dall is in the United States National Museum, no. 187233 from the *Fish Hawk*, station 7571, off Fowey Rocks, Miami, Florida in 45 fathoms. The holotype of *C. faustum* Schwengel and McGinty is in the Academy Nat-

ural Sciences Philadelphia, no. 178786 (not 178635 as published). Paratypes are in the Museum of Comparative Zoology, no. 207073 and 204718, and in the United States National Museum, no. 617422. The type locality is Lake Worth, Florida in 80 fathoms.

Remarks. This is a relatively rare species as our records would indicate. *C. faustum* is based upon a young specimen of *C. marionae*.

C. marionae is not closely related to any Western Atlantic species known to us. In sculpture it simulates *C. conulum* Linné of the western Mediterranean Sea. In both, the first 3 or 4 post-embryonic whorls have finely beaded cords; the remaining whorls have the cords smooth, flat, relatively broad and separated by fine grooves. *C. conulum* is, however, imperforate while *C. marionae* is umbilicate.

Range. From off St. Augustine, Florida, the west coast of Florida to off Campeche, Mexico in 23 to 90 fathoms.

Specimens examined. FLORIDA: *Combat*, station 101, about 50 miles E of St. Augustine ($29^{\circ}48' N$; $80^{\circ}23' W$) in 23 fathoms (H. Bullis); Lake Worth in 60–90 fathoms (ANSP; USNM; MCZ); *Fish Hawk*, station 7571 off Fowey Rocks, Miami, in 45 fathoms (USNM); off Tortugas in 15 fathoms (T. McGinty); *Oregon*, station 1022, about 45 miles N of Tortugas ($24^{\circ}59' N$; $83^{\circ}35' W$) in 39 fathoms; *Oregon*, station 1020 about 22 miles NW of Tortugas ($24^{\circ}47' N$; $83^{\circ}18' W$) in 35 fathoms; *Oregon*,

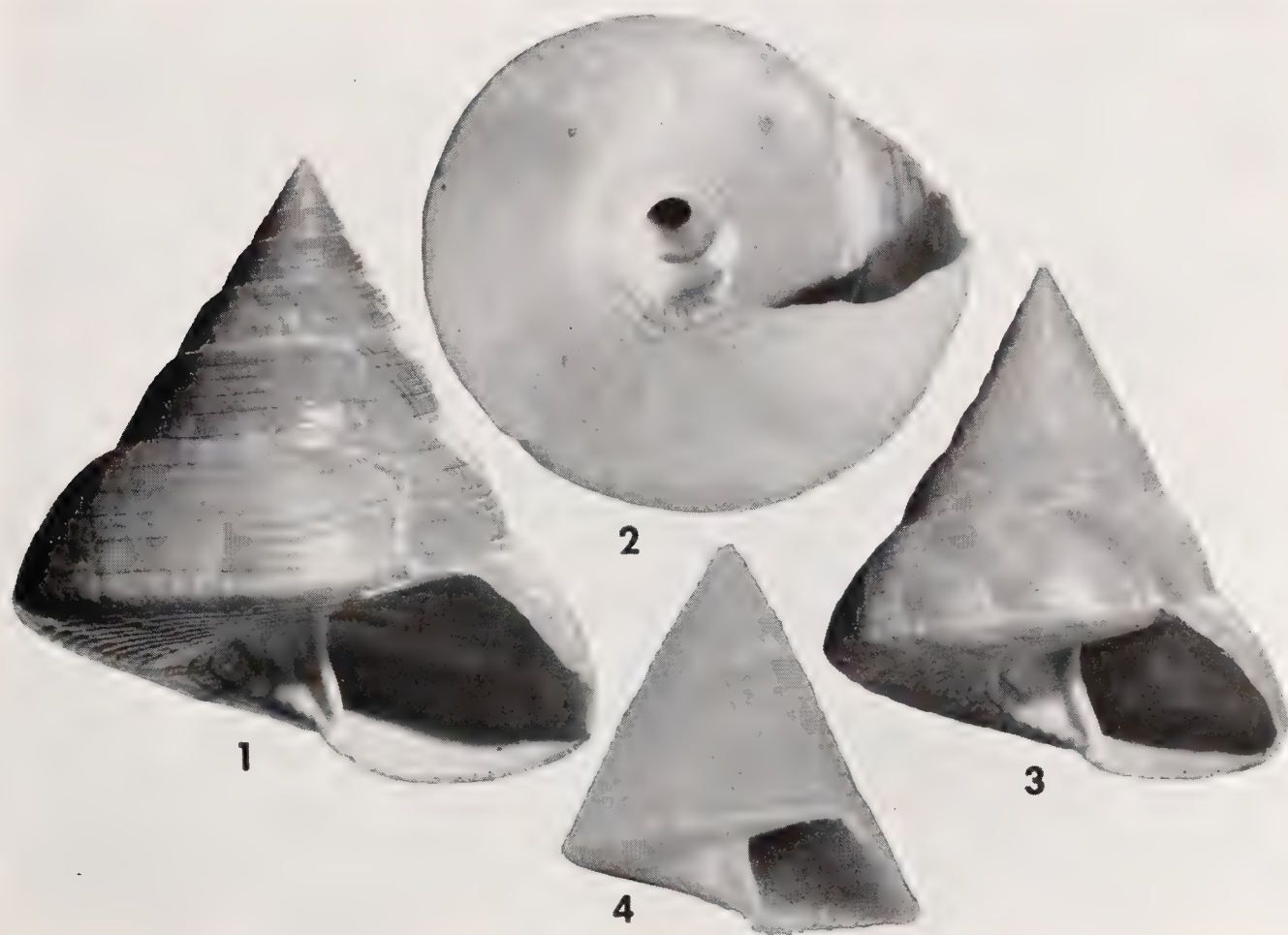


Plate 33. *Calliostoma marionae* Dall. Fig. 1. *Combat*, station 101, about 50 miles E of St. Augustine, Florida. Fig. 2. *Eolis*, station 187, off Fowey Rocks, Florida in 45 fathoms. Fig. 3. *Fish Hawk*, station 7571, off Fowey Rocks, Florida in 45 fathoms. Holotype. Fig. 4. *C. faustum* Schwengel (= *C. marionae* Dall), Lake Worth, Florida. Holotype (figs. 1–3, all 3x; fig. 4, 5.3x).

station 896, about 131 miles W of Cedar Keys ($28^{\circ}50'$ N; $85^{\circ}06'$ W) in 35 fathoms; *Oregon*, station 917, about 131 miles W of Tarpon Springs ($28^{\circ}22'$ N; $84^{\circ}53'$ W) in 48 fathoms (all H. Bullis); SW of Egmont Key in 90 fathoms; SSW of Johns Pass, off St. Petersburg in 29 fathoms (both D. Steger). MEXICO: off Campeche (W.C. Frisbey).

SPECIES NOT ASSIGNED TO SUBGENERA

The species which follow cannot be placed in a subgenus until the jaws and the radulae are known. The relationships of these species as given in the *Remarks* are based entirely upon shell characters. They will be of aid in determining a species but do not necessarily indicate actual relationship.

Calliostoma indiana Dall

Plate 34, fig. 1

*Calliostoma (Eucasta)*¹ *indiana* Dall 1889, Bulletin Museum Comparative Zoology **18**: 368, pl. 32, figs. 3, 5 (*Blake*, station 267, off Grenada, $12^{\circ}05'$ N; $51^{\circ}47'$ W, in 170 fathoms).

Description. Shell reaching 8 mm. (about $\frac{1}{3}$ inch) in length, trochoid, imperforate, rather thin in structure and coarsely sculptured. Color ivory-white with irregular patches of light brownish red. Whorls $7\frac{1}{2}$, flat sided and with a sharp keel. Spire extended and produced at an angle of about 55° . Aperture subquadrate, the outer lip simple and produced at an angle of about 45° from the base. Columella white, arched inwardly, slightly thickened and truncate. Suture indistinct. Sculpture consisting of numerous spiral cords which are coarsely beaded, alternating with finer beaded cords, the peripheral cord being the most coarsely sculptured. On the flattened base there are 6 or 7 finer cords with the beads smaller and somewhat lengthened. Axial sculpture consists of numerous and somewhat regular thin thread-like ridges which cross the spiral cords at the point of the beads and give the shell a fine reticulated pattern. Nuclear whorls $1\frac{1}{2}$, white and smooth. Operculum unknown.

length	width	
8 mm.	6.5 mm.	Holotype

Types. The holotype of *C. indiana* Dall is in the United States National Museum, no. 214273. The type locality is *Blake*, station 247, off Grenada ($12^{\circ}05'$ N; $61^{\circ}41'$ W) in 170 fathoms.

Remarks. Dall overemphasized many of the characters which he mentioned in his original description, creating an impression of greater differences between this and other species of *Calliostoma* than actually exist. The fasciole which he mentions in his description of *indiana* is nothing more than the interspaces between two of the spiral cords.

On shell characters this species appears to be close to both *C. roseolum* Dall and *C. pulchrum* C. B. Adams, differing from *roseolum* by its much flatter whorls and finer basal

¹ Dall erected the section *Eucasta* (1889, Bull. Mus. Comp. Zool. **18**: 368) for a single species, *Calliostoma indiana* Dall, which was based upon a single dead specimen. As discussed in the remarks under *C. indiana*, he overemphasized many of the characters, implying differences between this and other species of *Calliostoma* which certainly do not exist. Based on shell characters only, *Eucasta* is probably a synonym of *Calliostoma* s.s.

cords. The spiral cords in *C. indiana* are more widely spaced than in either of these species, the keel is sharper and there is a definite axial sculpture giving the shell a reticulated pattern. *Calliostoma indiana* is also similar in appearance to *C. sapidum* Dall but is much more finely sculptured.

Range and Specimens examined. Known only from the type locality.

Calliostoma sapidum Dall

Plate 34, fig. 2

Calliostoma sapidum Dall 1881, Bulletin Museum Comparative Zoology **9**: 46 (*Blake*, station 2, off Habana, Cuba, 23°14' N; 82°25' W, in 805 fathoms); Dall 1889, Bull. Mus. Comparative Zoology **18**: 364, pl. 21, fig. 214.

Description. Shell reaching 6.2 mm. (about $\frac{1}{4}$ inch) in length, trochoid, imperforate, rather strong in structure and finely sculptured. Color ivory-white with occasional spots of very faint reddish brown. Whorls 8, flat sided and sharply keeled. Spire extended and produced at an angle of about 45°. Aperture subquadrate, outer lip simple and produced at an angle of about 40° from the base. Columella white, nearly straight and truncated. Suture indistinct, indicated mainly by the larger size of the peripheral cord. Sculpture consisting of numerous, rather coarsely beaded cords with the peripheral cord being largest and more coarsely beaded. There are 4 beaded cords, including the peripheral one, above the periphery. There are 8 smooth cords on the flattened base. Nuclear whorl small, white and smooth. Operculum unknown.

length	width	
6.2 mm.	5.4 mm.	Holotype
5.4	4.2	Barbados

Types. The holotype of *Calliostoma sapidum* Dall is in the United States National Museum, no. 214271. The type locality is *Blake*, station 2, off Habana, Cuba (23°14' N; 82°25' W) in 805 fathoms.

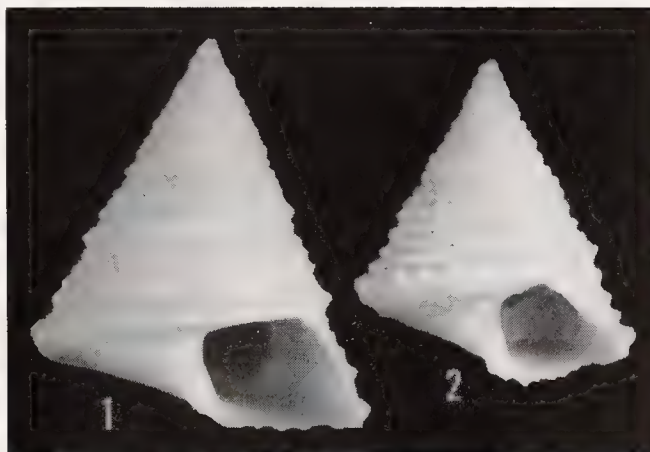


Plate 34. Fig. 1. *Calliostoma indiana* Dall, *Blake*, station 247, off Grenada, Lesser Antilles in 170 fathoms. Holotype (5.3x). Fig. 2. *Calliostoma sapidum* Dall, *Blake*, station 2, off Habana, Cuba in 805 fathoms. Holotype (5.3x).

Remarks. The description of this species was based upon dead specimens only. It is perhaps most closely related to *C. pulchrum* C. B. Adams from which it differs by being smaller in size and in having the peripheral cord heavier and more strongly beaded. See also *Remarks* under *C. indiana* Dall.

Specimens examined. FLORIDA: 90 miles SW of Egmont Key in 66 to 70 fathoms (D. Steger). CUBA: *Blake*, station 2, off Habana (23°14' N; 82°25' W) in 805 fathoms (USNM). LESSER ANTILLES: off Barbados in 80 fathoms; off Pelican Island, Barbados in 100 fathoms; off English Harbour, Antigua in 120 fathoms (all USNM).

Calliostoma orion Dall

Plate 35; figs. 1-2

Calliostoma orion Dall 1889, Bulletin Museum Comparative Zoology **18**: 367, pl. 28, fig. 2 (*Blake*, station 62, off Habana, Cuba in 80 fathoms).

Description. Shell reaching 12.5 mm. (about $\frac{1}{2}$ inch) in length, trochoid in shape, imperforate, thin in structure and finely sculptured. Color a uniform ivory-white. Whorls 9, moderately convex with a rounded keel. Spire moderately extended and produced at

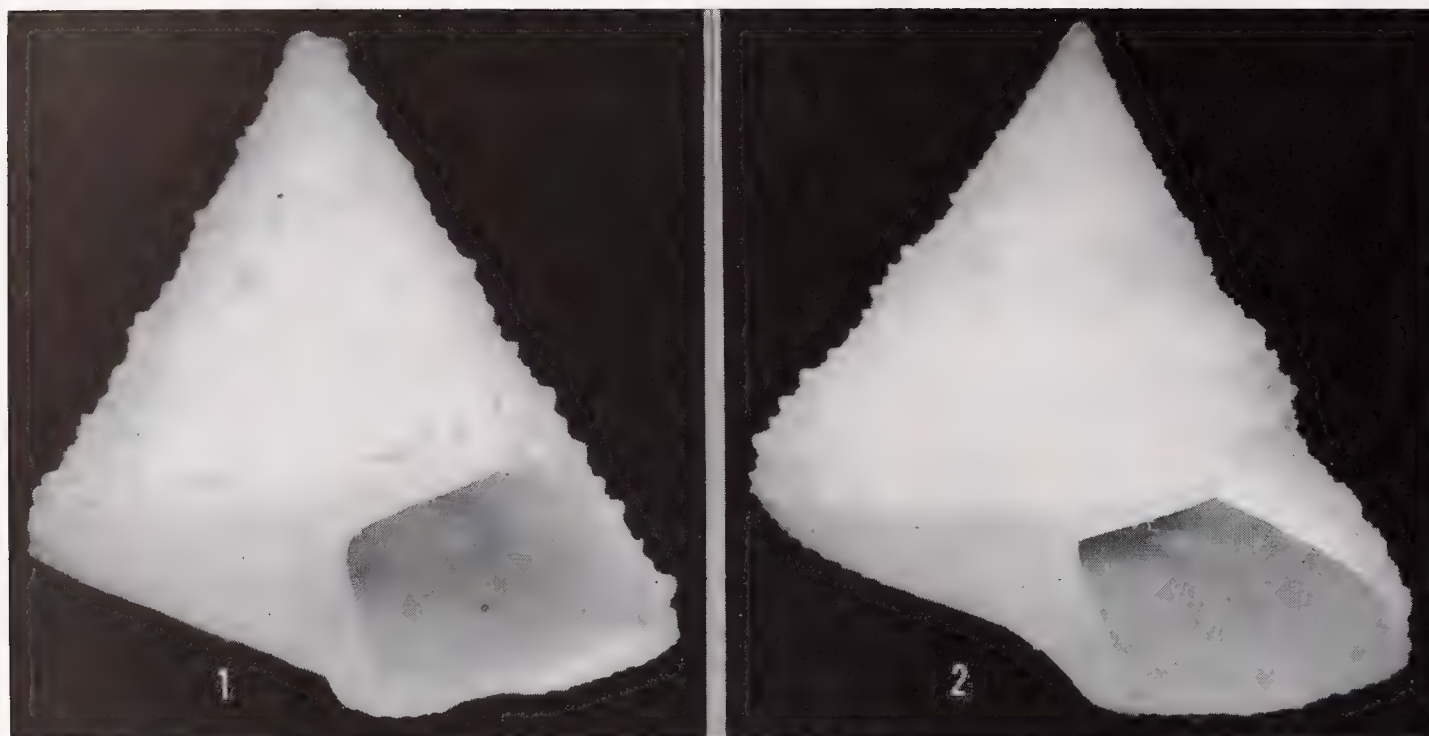


Plate 35. *Calliostoma orion* Dall. Fig. 1. *Blake*, station 62, off Habana, Cuba in 80 fathoms. Holotype (17.5x). Fig. 2. Arenas de la Chorrera, Habana, Cuba (6x).

an angle of about 70°. Aperture subquadrate, outer lip simple and produced at an angle of about 40° from the base. Columella white, slightly arched and subtruncate. Suture indistinct. Sculpture consisting of numerous fine beaded cords above the periphery; below the periphery the cords are much finer and the beading exceedingly fine. There are four peripheral cords, the outer two being larger and more coarsely beaded. The beads are more or less pointed. Nuclear whorls $1\frac{1}{2}$, smooth and white. Operculum unknown.

length	width	
12.5 mm.	11.5 mm.	Habana, Cuba
4.4	4	Holotype

Types. The holotype of *Calliostoma orion* Dall is in the United States National Museum, no. 214272. The type locality is *Blake*, station 62, off Habana, Cuba in 80 fathoms.

Remarks. This species appears to be allied to *C. echinatum* Dall differing by having the spiral cords more numerous and much more finely beaded. The peripheral cord is only slightly larger than the rest while in *echinatum* it is pronounced.

There are only two known specimens of this species. The holotype specimen is a very young shell. The second specimen is probably fully adult.

Range. Known only from the vicinity of Habana, Cuba.

Specimens examined. CUBA: *Blake*, station 62, off Habana in 80 fathoms (USNM). Arenas de la Chorrera, Habana, Cuba (V. Condé).

Calliostoma echinatum Dall

Plate 36

Calliostoma echinatum Dall 1881, Bulletin Museum Comparative Zoology **9**: 47; Dall 1889, Bulletin Museum Comparative Zoology **18**: 364, pl. 21, figs. 2a, 5 (*Blake*, station 62, off Habana, Cuba in 80 fathoms).

Description. Shell reaching 5 mm. (about $\frac{1}{4}$ inch) in length (a young specimen), trochoid in shape, imperforate, thin in structure and highly sculptured. Whorls 6, moderately convex. Spire moderately extended and produced at an angle of about 50° . Aperture subquadrate, outer lip simple and produced at an angle of about 40° from the base. Columella nearly straight, narrow and forming a near right angle with the base of the shell. Suture indistinct. The sculpture consists of 7 beaded cords above the periphery which generally alternate between large and small. Below the periphery there are 13 very small and faintly beaded cords. Nuclear whorls $1\frac{1}{2}$, white and smooth. Operculum unknown.



Plate 36. *Calliostoma echinatum* Dall. *Blake*, station 62, off Habana, Cuba in 80 fathoms. Holotype (15.7x).

length	width	
5 mm.	4.5 mm.	Holotype

Types. The holotype of *Calliostoma echinatum* Dall is in the United States National Museum, no. 214270. The type locality is *Blake*, station 62, off Habana, Cuba in 80 fathoms.

Remarks. This species probably is most closely related to *C. orion* Dall from which it differs in being more coarsely sculptured and in having the whorls flat sided. The holotype is an uncolored, young specimen and until more material is available its position must remain uncertain. See also under *C. orion* Dall.

Range and Specimens examined. Known only from the type specimen.

Calliostoma sarcodum Dall

Plate 37, figs. 1-2

Calliostoma sarcodum Dall 1927, Proc. United States National Museum **70**: 7 (off "Lord's Castle," Barbados in 4-6 fathoms).

Calliostoma jaumei Clench and Aguayo 1946, Revista de la Sociedad Malacologica **4**: 88, text figure (Arenas de la Chorrera, Habana, Cuba.)

Description. Shell reaching 10 mm. ($\frac{3}{8}$ inch) in length, turbate, solid in structure, finely sculptured and perforate. Color a uniform medium to dark brownish red, some specimens having a few small white patches on the spire. On the base and occasionally at the periphery of some specimens, two or more of the beaded spiral cords are marked with interrupted deep reddish spots. Whorls 7 to 8, slightly convex, and not keeled. Base of shell slightly convex, spire moderately extended and produced at an angle of 75° . Aperture subquadrate, the outer lip simple and produced at an angle of about 45° from the base. Columella thickened, white in color and inclined to the right of the axis. Umbilical area defined by a shallow depression. Suture slightly indented but obscure. Sculpture consisting of numerous fine beaded cords, the cords on the base being somewhat finer than those above the periphery. Nuclear whorls $1\frac{1}{2}$, very small and smooth. Operculum unknown.

length	width	
9 mm.	9.5 mm.	Holotype of <i>C. jaumei</i>
7.5	7.5	Holotype of <i>C. sarcodum</i>
10	10.5	Turks Islands, Bahama Islands
9.5	9.5	St. Croix, Virgin Islands

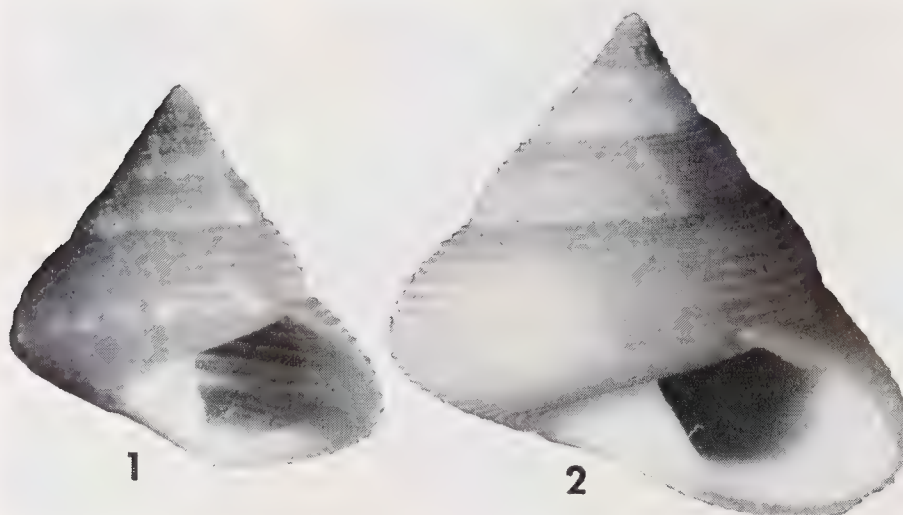


Plate 37. *Calliostoma sarcodum* Dall. Fig. 1. Holotype of *Calliostoma sarcodum* Dall, off "Lord's Castle," Barbados in 4 to 6 fathoms (5.3x). Fig. 2. Holotype of *C. jaumei* Clench and Aguayo [= *C. sarcodum* Dall], Arenas de la Chorrera, Habana, Cuba (about 5.5x).

Types. The holotype of *C. sarcodum* Dall is in the United States National Museum, 216955, from off "Lord's Castle," Barbados in 4 to 6 fathoms. The holotype of *C. jaumei* Clench and Aguayo is in the Museum of Comparative Zoology, no. 178127, from the Arenas de la Chorrera, Habana, Cuba.

Remarks. This is a rare species to judge by the amount of material we have had for study. It is apparently a fairly shallow water species, living in sandy areas.

Calliostoma jaumei Clench and Aguayo is a unicolored form of *sarcodum* Dall and has no significance even as a geographic race. Dall did not figure his species but a study of the holotype specimen indicates that they are the same species.

Calliostoma sarcodum, on the basis of shell characters, appears to be most closely related to *C. euglyptum* Adams.

Range. The Bahama Islands and south through the Greater and Lesser Antilles to Barbados.

Specimens examined. BAHAMA ISLANDS: Clifton Point, New Providence (T. McGinty); Turks Islands (MCZ). CUBA: Arenas de la Chorrera, Habana (MCZ; V. Condé; D. Steger); Cayo Santa Maria, Camagüey (MCZ). PUERTO RICO: Rincón (G. Warmke). VIRGIN ISLANDS: St. Thomas (USNM); St. Croix (G. Usticke). LESSER ANTILLES: off "Lord's Castle" Barbados (USNM).

***Calliostoma carcellesi* Clench and Aguayo**

Plate 38, figs. 1-2; Plate 39

Calliostoma (Calliostoma) carcellesi Clench and Aguayo 1940, Memorias de la Sociedad de Historia Natural 14: 80, pl. 14, fig. 4 (*Hassler* voyage, off Punta Rubio, Argentina, 40°22' S; 60°35' W, in 30 fathoms).

Description. Shell reaching 20.5 mm. (about $\frac{3}{4}$ inch) in length, trochoid in shape, imperforate, rather thin but strong in structure and finely sculptured. Color a uniform ivory-white. Whorls $8\frac{1}{2}$ to 9, moderately convex with a rounded keel. Spire extended and produced at an angle of about 55°. Aperture subquadrate, the outer lip simple and

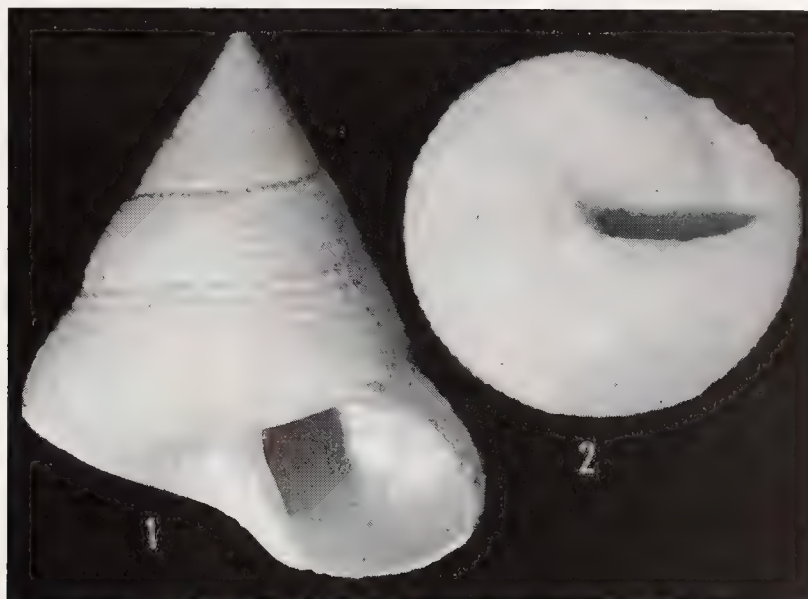


Plate 38. *Calliostoma carcellesi* Clench and Aguayo. Fig. 1. *Hassler*, station 27, about 100 miles E of Bahía Anegada, Río Negro Prov., Argentina in 30 fathoms. Holotype. Fig. 2. *Hassler*, station 30, about 50 miles S of Punta Redonda, Río Negro Prov., Argentina in 30 fathoms. Paratype (both 2.8x).

produced at an angle of about 55° from the base. Columella iridescent, slightly arched and subtruncate at the base of the aperture. Suture slightly indented. Sculpture consists of numerous fine, beaded cords above the whorl periphery; below the periphery the cords are finer, more thread-like and interrupted only by the growth lines. Operculum thin, corneous and circular.

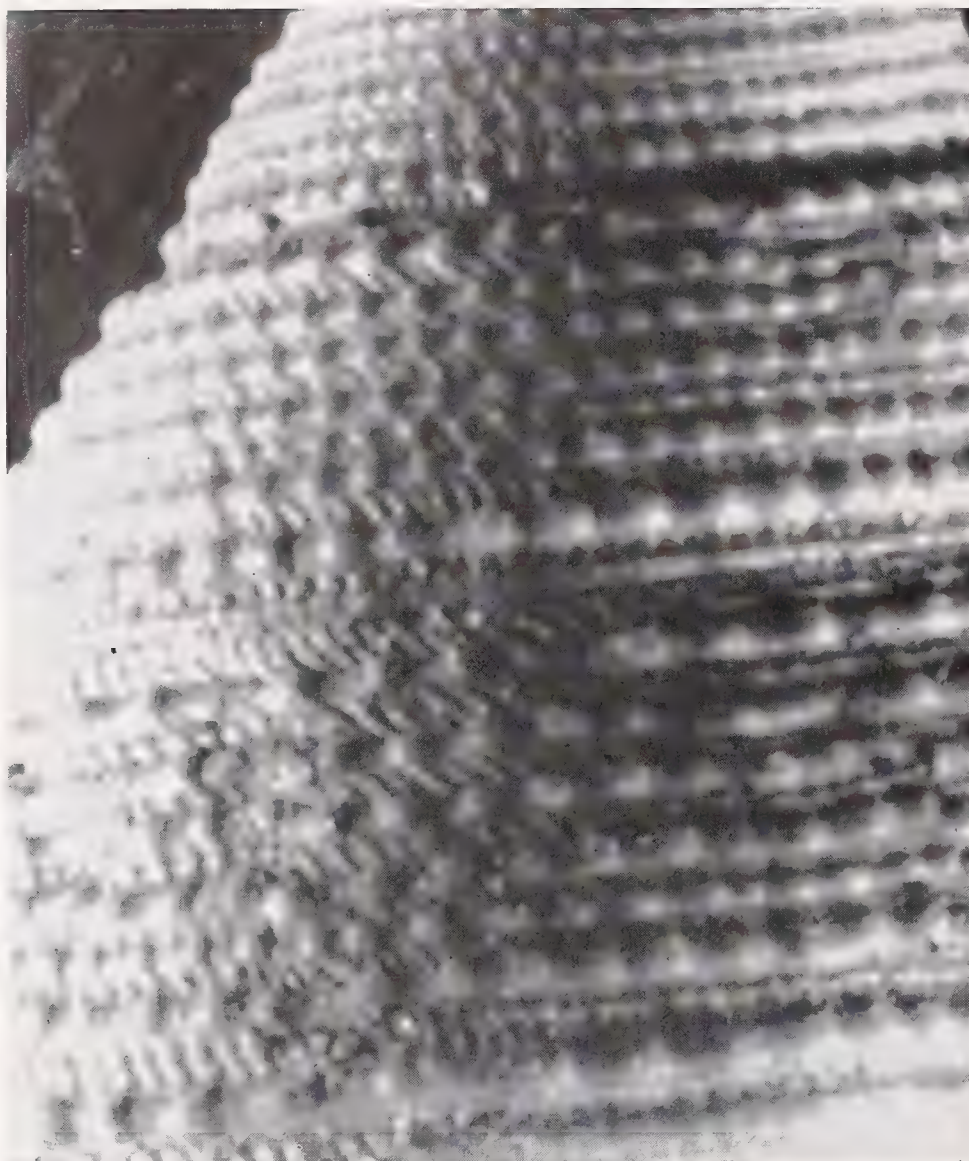


Plate 39. *Calliostoma carcellesi* Clench and Aguayo. Off Punta Rubio, Argentina. Holotype (about 16.5x).

length	width	
20.5 mm.	17.1 mm.	Holotype
17.1	14.2	Paratype (Museo Poey)

Types. The holotype of *Calliostoma carcellesi* is in the Museum of Comparative Zoology, no. 104719, from the voyage of the *Hassler*, station 27, about 100 miles E of Bahía Anegada, Río Negro Prov., Argentina ($40^\circ 22' \text{ S}$; $60^\circ 35' \text{ W}$) in 30 fathoms. Paratypes from the same locality are in the Museum of Comparative Zoology and the Museo Poey, University of Habana, Habana, Cuba.

Remarks. On the basis of shell characters this species appears to be most closely related to *C. jucundum* Gould but differs in being more attenuate, having slightly convex rather than flat sided whorls and being a uniform ivory in color. In addition, the base of the body whorl in *jucundum* is flatter and the sculpture, though similar, is somewhat coarser.

Range. Known only from off the Province of Río Negro, Argentina.

Specimens examined. ARGENTINA: *Hassler*, station 27, about 100 miles E of Bahía Anegada, Río Negro Prov. ($40^{\circ}22'$ S; $60^{\circ}35'$ W) in 30 fathoms; *Hassler*, station 30, about 45 miles S of Punta Redondo, Río Negro Prov. ($41^{\circ}40'$ S; $63^{\circ}13'$ W) in 30 fathoms (both MCZ).

***Calliostoma torrei* Clench and Aguayo**

Plate 40

Calliostoma (Calliostoma) torrei Clench and Aguayo 1940, Memorias de la Sociedad Cubana de Historia Natural 14: 79, pl. 14, fig. 5 (off Matanzas, Matanzas Prov., Cuba in 385 fathoms).

Description. Shell reaching 41 mm. (about $1\frac{1}{2}$ inches) in length, trochoid in shape, solid in structure, imperforate and rather coarsely sculptured. Color a light reddish brown [dead specimen]. Whorls $9\frac{1}{2}$, flat sided and with a broad keel at the whorl periphery. Base of shell convex. Spire moderately extended and produced at an angle of 66° [not 76° as given in the original description]. Aperture subquadrate, outer lip simple and produced at an angle of about 40° from the base. Columella thick, inwardly arched and obtusely angled with the base of the aperture. Suture distinct. Sculpture consisting of 19 finely beaded spiral cords above the periphery and about 22 non-beaded spiral cords below the periphery. Nuclear whorls $1\frac{1}{2}$, small, smooth and glass-like, the first two post-nuclear whorls finely axially costate. Operculum unknown.



Plate 40. *Calliostoma torrei* Clench and Aguayo. *Atlantis*, station 3985, off Matanzas, Cuba in 385 fathoms. Holotype (2.6x).

length	width	
41 mm.	36 mm.	Holotype

Types. Holotype, Museum of Comparative Zoology, no. 135165, *Atlantis*, station 3985 from off Matanzas, Matanzas Prov., Cuba ($23^{\circ}13' N$; $81^{\circ}22' W$) in 385 fathoms.

Remarks. This species is known only from the type specimen. It is one of the largest species of *Calliostoma* in the Western Atlantic and is exceeded in size by but few species elsewhere. This is a very distinctive species and apparently not closely related to any other in the Western Atlantic though it seems to be closest to *C. amazonicum* Finlay. See *Remarks* under that species.

Range and Specimens examined. Known only from the type locality.

Calliostoma amazonicum Finlay

Plate 41; Plate 42

Calliostoma iheringi Dall 1927, Proc. United States National Museum **70**: Art. 19, p. 5 (Nicochea, Brasil [Necochea, Argentina]).

Calliostoma amazonica Finlay 1930, Trans. New Zealand Institute **61**: 40 [new name for *C. iheringi* Dall 1927, non *C. iheringi* Ortmann 1900].

Calliostoma quequensis Carcelles 1944, Revista del Museo de la Plata (N.S.) Zoologia **3**: 241 [new name for *C. iheringi* Dall 1927, non *C. iheringi* Ortmann 1900].



Plate 41. *Calliostoma amazonicum* Finlay. Puerto Quequén, Argentina (2.3x).

Description. Shell reaching 34 mm. (about $1\frac{1}{4}$ inches) in length, trochoid in shape, solid in structure, rather coarsely sculptured and imperforate. Color ivory-white, mottled lightly with reddish brown in a more or less diagonal pattern. Whorls $5\frac{1}{2}$, strongly convex, with two large cords at the rounded whorl periphery. Base of shell convex. Spire moderately extended and produced at an angle of about 75° . Aperture subquadrate, outer lip simple and produced at an angle of about 35° from the base. Columella rather thin, inwardly arched and obtusely angled with the base of the aperture. Suture indis-

inct. Sculpture consisting of numerous beaded cords. Above the periphery large and small cords alternate while below the periphery they are of equal size. Nuclear whorls $1\frac{1}{2}$, small, smooth and glass-like. Operculum unknown.



Plate 42. *Calliostoma amazonicum* Finlay. Holotype of *Calliostoma iheringi* Dall [= *amazonicum* Finlay] Necochea, Brasil [Necochea, Argentina] (about 2x).

length	width	
34 mm.	34 mm.	Holotype
34	32	Puerto Quequén, Argentina

Types. The holotype of *C. iheringi* Dall [= *amazonicum* Finlay] is in the United States National Museum, no. 333701. The type locality, Necochea, Brazil as given by Dall was in error; it is Necochea, Prov. of Buenos Aires, Argentina.

Remarks. This species is known from only a very few specimens. It is, however, very distinctive and on shell characters would appear to be a member of the *atlantis-torrei* complex. From *C. torrei* Clench and Aguayo it differs by being somewhat smaller, proportionately wider, having a more coarsely beaded sculpture and more convex whorls.

Range. From Necochea and Puerto Quequén south and west to Monte Hermosa, Argentina.

Specimens examined. ARGENTINA: Puerto Quequén (ANSP); Necochea and Monte Hermosa (both USNM), all in the Prov. of Buenos Aires.

***Calliostoma cubanum* Clench and Aguayo** Plate 43

Calliostoma (*Calliostoma*) *cubanum* Clench and Aguayo 1940, Memorias de la Sociedad Cubana de Historia Natural 14: 78, pl. 16. fig. 4 (*Atlantis*, station 3474, off Cárdenas, Matanzas Prov., Cuba, $23^{\circ}18' N$; $80^{\circ}46' W$, in 490 fathoms).

Description. Shell about 15 mm. ($\frac{5}{8}$ inch) in length, trochoid in shape, solid in structure, minutely perforate and coarsely sculptured. Color probably yellowish brown [dead specimen]. Whorls probably about 9, rather flat sided and with a double knobbed keel

at the periphery. Spire moderately extended and produced at an angle of 65° . Aperture subquadrate, outer lip simple and produced at an angle of 55° from the base. Columella narrow, inwardly arched and obtusely angled with the base of the aperture. Suture indistinct. Sculpture consisting of coarsely beaded spiral cords, the uppermost peripheral cord being the strongest; between this cord and the suture above there are five alternating fine and coarse beaded cords. Between the upper and the lower peripheral cord there is a broad smooth band. The base of the whorl has 13 fine, smooth, spiral cords. The umbilicus is finely perforated. The periostracum, nuclear whorls and operculum are unknown.

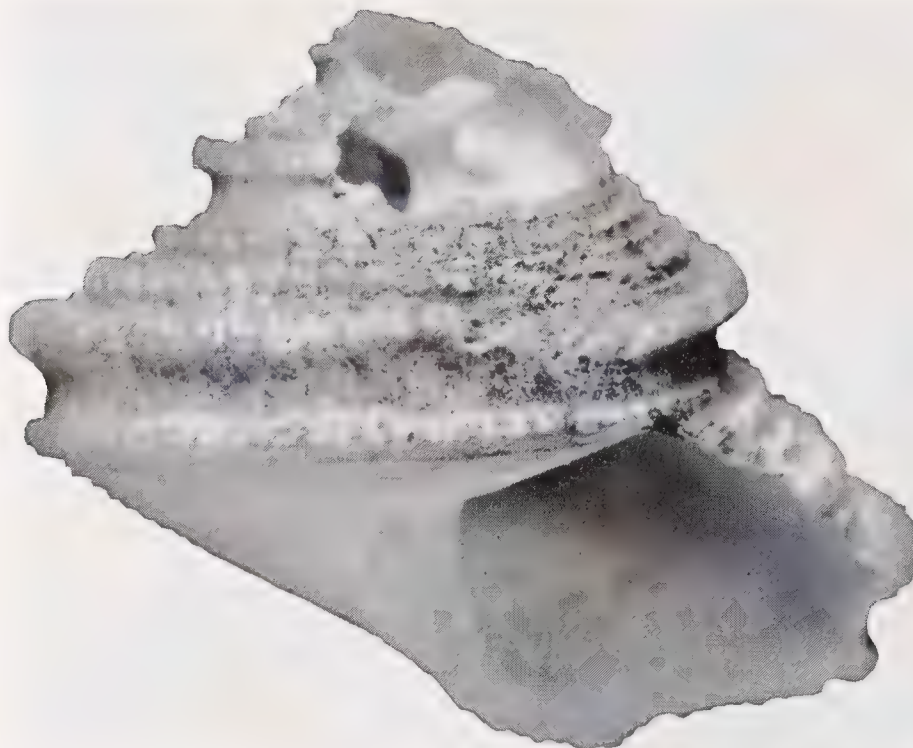


Plate 43. *Calliostoma cubanum* Clench and Aguayo. *Atlantis*, station 3474, off Cárdenas, Matanzas Province, Cuba in 490 fathoms. Holotype (about 5.3x).

length	width	
15 mm. (estimated)	16.5 mm.	Holotype

Types. Holotype, Museum of Comparative Zoology, no. 135163, *Atlantis*, station 3474, off Cárdenas, Matanzas Province, Cuba ($23^\circ 18' N$; $80^\circ 46' W$) in 490 fathoms.

Remarks. The description above is based on a single dead and broken specimen. It is a member of the *atlantis-torrei* species complex which is characterized by having two well marked cords at the periphery of the whorl with a broad smooth area between them, the suture being built on the lower cord.

This is the most highly sculptured *Calliostoma* in the Western Atlantic.

***Calliostoma atlantis* Clench and Aguayo**

Plate 44

Calliostoma (*Calliostoma*) *atlantis* Clench and Aguayo 1940, Memorias de la Sociedad Cubana de Historia Natural 14: 81, pl. 15, fig. 4 (*Atlantis*, station 3306, off Mariel, Pinar del Río, Cuba, $23^\circ 04' N$; $82^\circ 37' W$, in 330 fathoms).

Description. Shell reaching 35.5 mm. ($1\frac{1}{4}$ inches) in length, turbinate, solid in structure, imperforate, sculptured and shining. Color a creamy white and opalescent. Whorls

eight, acutely angled and regularly increasing in size. Base of shell convex. Spire acute, moderately extended and produced at an angle of about 80° . Aperture subquadrate and produced at an angle of about 45° from the base. Outer lip simple; inner lip consisting of a very thin glaze. Columella thickened and nearly straight. Umbilical depression slight. Suture slightly indented with the upper margin of the aperture being built forward on the lower of the two peripheral keels. Sculpture consists of the two beaded keels, the beading becoming obsolete on the lower keel of the body whorl. Microscopic sculpture consisting of numerous fine, somewhat irregular spiral threads. Axial sculpture of very fine and irregular growth lines. Nuclear whorl smooth and white, the early post-nuclear whorls finely reticulate. Operculum thin, corneous and multispiral with a central nucleus.

length	width	
31.5 mm.	32.5 mm.	Holotype

Types. The holotype is in the Museum of Comparative Zoology, no. 135164 from *Atlantis*, station 3306, off Mariel, Pinar del Río, Cuba ($23^{\circ}04'$ N; $82^{\circ}37'$ W) in 330 fathoms.

Remarks. The *Atlantis* obtained only a single specimen of this species. In general shell shape it is similar to *C. torrei* Clench and Aguayo, and *C. amazonica* Finlay, but differs in being nearly devoid of sculpture. The shell also resembles that of *C. schroederi* Clench and Aguayo from which it differs in having the beading on the keels exceedingly fine, having fine spiral threads, and a strongly convex base. In addition, *C. atlantis* is devoid of any spiral bands of color.

Range and Specimens examined. Known only from the type specimen.



Plate 44. *Calliostoma atlantis* Clench and Aguayo. *Atlantis*, station 3306, off Mariel, Cuba in 330 fathoms. Holotype (about 2.8x).

Calliostoma aurora Dall

Plate 45, figs. 1-2; Plate 46

Calliostoma aurora Dall 1888 [in] Agassiz, Three Cruises of the Steamer "Blake." Bull. Mus. Comp. Zool. **15**: 68, fig. 285 (no locality given); Dall 1889, Bull. Mus. Comp. Zool. **18**: 366, pl. 37, fig. 2 (off Grenada and off Barbados).

Description. Shell reaching 21 mm. ($\frac{3}{4}$ inch) in length, trochoid in shape, thin, imperforate and finely sculptured. Color a uniform straw-yellow above the periphery and a light cream color below. Whorls probably 10, slightly convex with a pronounced, sharp keel at the whorl periphery. Spire moderately extended, concave and produced at an angle of about 70° . Aperture subquadrate, outer lip simple and produced at an angle of 50° from the base. Columella slightly arched. Umbilical area smooth and iridescent. Suture very indistinct. Sculpture consisting of 12 beaded cords on the body whorl above the periphery, while below the periphery the shell is smooth except for the very fine growth lines. The umbilical area is margined by two rather indistinct cords. Operculum unknown. Periostracum very thin and straw-yellow in color. Nuclear whorls $1\frac{1}{2}$, white and smooth.

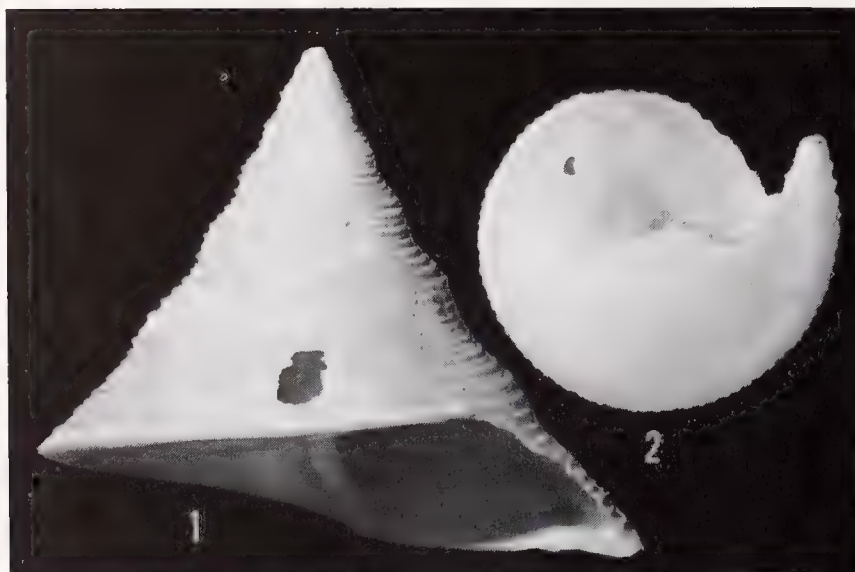


Plate 45. *Calliostoma aurora* Dall. Fig. 1. *Blake*, station 265, off Grenada, Lesser Antilles in 576 fathoms. Holotype. Fig. 2. *Blake*, station 299, off Barbados, Lesser Antilles in 140 fathoms. Paratype (both 2.4x).

length	width	
21 mm.	26.5 mm.	Holotype
8	15.5	off Barbados, Lesser Antilles

Types. The holotype is in the Museum of Comparative Zoology, no. 73808, from *Blake*, station 265, off the west coast of Grenada, Lesser Antilles ($12^\circ 03' 55''$ N; $61^\circ 49' 40''$ W) in 576 fathoms. Paratypes in the United States National Museum, no. 95005, are from *Blake*, station 299, off the west coast of Barbados, Lesser Antilles ($13^\circ 05' 00''$ N; $59^\circ 39' 40''$ W) in 140 fathoms.

Remarks. This is a very rare and beautiful species and on the basis of its shell characters it may be compared to *C. bairdii* Verrill and Smith, and *C. psyche* Dall. It is readily distinguished, however, by its lighter structure, concave spire, finer sculpture, smooth base and uniform coloration. See also *Remarks* under *C. jeanneae* Clench and Turner.

Range and Specimens examined. This species is known only from the two localities given under types.

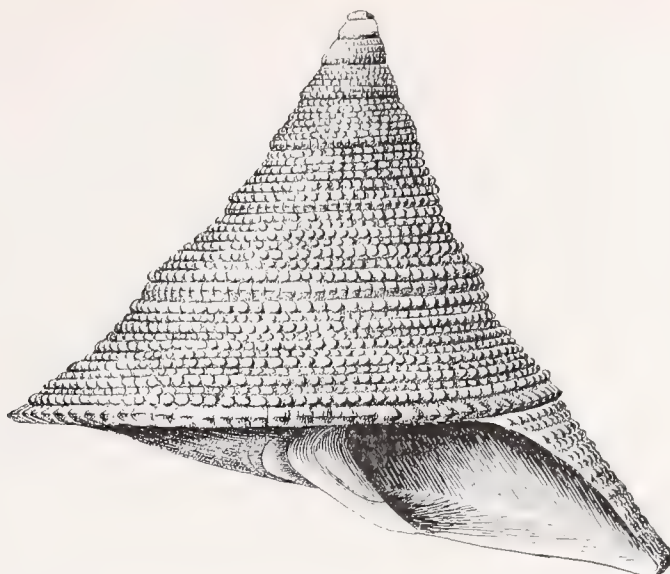


Plate 46. *Calliostoma aurora* Dall. This figure appeared first in a chapter by W. H. Dall in Alexander Agassiz' report on "Three Cruises of the United States Coast and Geodetic Survey Steamer *Blake*" (1888, Bulletin Museum of Comparative Zoology **15**: 68, fig. 285). This is a new engraving of the original drawing by McConnell (2.6x).

***Calliostoma jeanneae*¹ new species**

Plate 47, figs. 1-2

Description. Shell reaching 11.5 mm. (about $\frac{1}{2}$ inch) in length, depressed trochoid, rather thin in structure, imperforate and very finely sculptured. Color iridescent with small, spirally arranged flecks of brown on the cords forming the periphery with smaller and much fainter spots of the same color on the whorl above the periphery. Below the periphery the spots are more elongate. Whorls $7\frac{1}{2}$, flat sided and with an acute keel at the whorl periphery; spire moderately depressed and produced at an angle of 70° . Aperture subquadrate, the outer lip simple and thin and produced at an angle of 30° from the base. Columella iridescent, slightly arched, truncate and margined on the parietal area with a strong, smooth cord. Suture indistinct. Spiral sculpture consists of two closely spaced smooth cords, the lower one being the larger and forming the acute keel at the periphery. Above these peripheral cords there are a few faint, regularly spaced incised lines. The two post-nuclear whorls are sculptured with 3 to 4 finely beaded cords. These cords disappear on the fourth whorl. Base of shell flat and with a few incised lines crossed by very fine growth lines. Nuclear whorls $1\frac{1}{2}$, white and smooth. Operculum unknown.

length	width	
11.5 mm.	13 mm.	Holotype

Types. The holotype of *C. jeanneae* is in the Museum of Comparative Zoology, no. 228370, from off Habana, Cuba, dredged by the *Atlantis*, but without station number.

Remarks. This species does not appear to be closely related to any other *Calliostoma* in the Western Atlantic. In general shape it is similar to *C. aurora* Dall, but this latter species has a concave spire and an elaborate beaded sculpture.

Range and Specimens examined. Known only from the type locality.

¹ It is a pleasure to name this species in honor of Dr. Jeanne S. Schwengel of Scarsdale, New York, who has done so much to help others in the field of Malacology.



Plate 47. *Calliostoma jeanneae* Clench and Turner. *Atlantis* cruise, off Habana, Cuba. Holotype. Fig. 1 (6.6x). Fig. 2 (5.5x).

***Calliostoma hassler* Clench and Aguayo**

Plate 48, figs. 1-2

Calliostoma (Astele) hassler Clench and Aguayo 1939, Memorias de la Sociedad Cubana de Historia Natural 13: 191, pl. 28, fig. 3 (off Cabo Frio, 75 miles E of Rio de Janeiro, Brasil).

Description. Shell reaching 30 mm. (about $1\frac{1}{4}$ inches) in length, trochoid in shape, rather light in structure, umbilicate and finely sculptured. Color pattern mottled with white and yellowish brown. Whorls 10, slightly convex, with a slightly rounded peripheral keel. Base of shell slightly convex. Spire extended and produced at an angle of 65° . Aperture subquadrate, the outer lip simple and cast at an angle of 55° from the base. Columella arched, thickened, white and not truncate. Umbilicus profound, white to slightly mottled with yellow. Spiral sculpture consisting of numerous fine, beaded cords with about 30 cords on the body whorl. There does not appear to be any axial sculpture. Operculum unknown.

length	width	
30 mm.	31 mm.	Holotype
31.6	32	Paratype
25	25.7	"

Types. The holotype is in the Museum of Comparative Zoology, no. 104554, from off Cabo Frio, Brasil in 35 fathoms. Paratypes are in the Museum of Comparative Zoology and the Museo Poey, Universidad de la Habana, Cuba, with the same data.

Remarks. On the basis of shell characters this species appears to be close in its relationships to both *C. javanicum* Lamarck and *C. barbouri* Clench and Aguayo, from which it differs by having a somewhat rounded rather than an acute keel and by lacking the colored spiral threads and axial sculpture. In addition, it has slightly convex rather than flat sided whorls and has a much finer mottled color pattern. From *C. jujubinum* it differs

in having a much lighter shell structure, being proportionately wider and in having a much wider umbilicus.

Range. Known only from the coast of Brasil between Salvador and Cabo Frio.

Specimens examined. BRASIL: Salvador [Baia] (USNM); off the Abrolhos Ids., Baia; off Cabo Frio, Est. Rio de Janeiro (both MCZ).

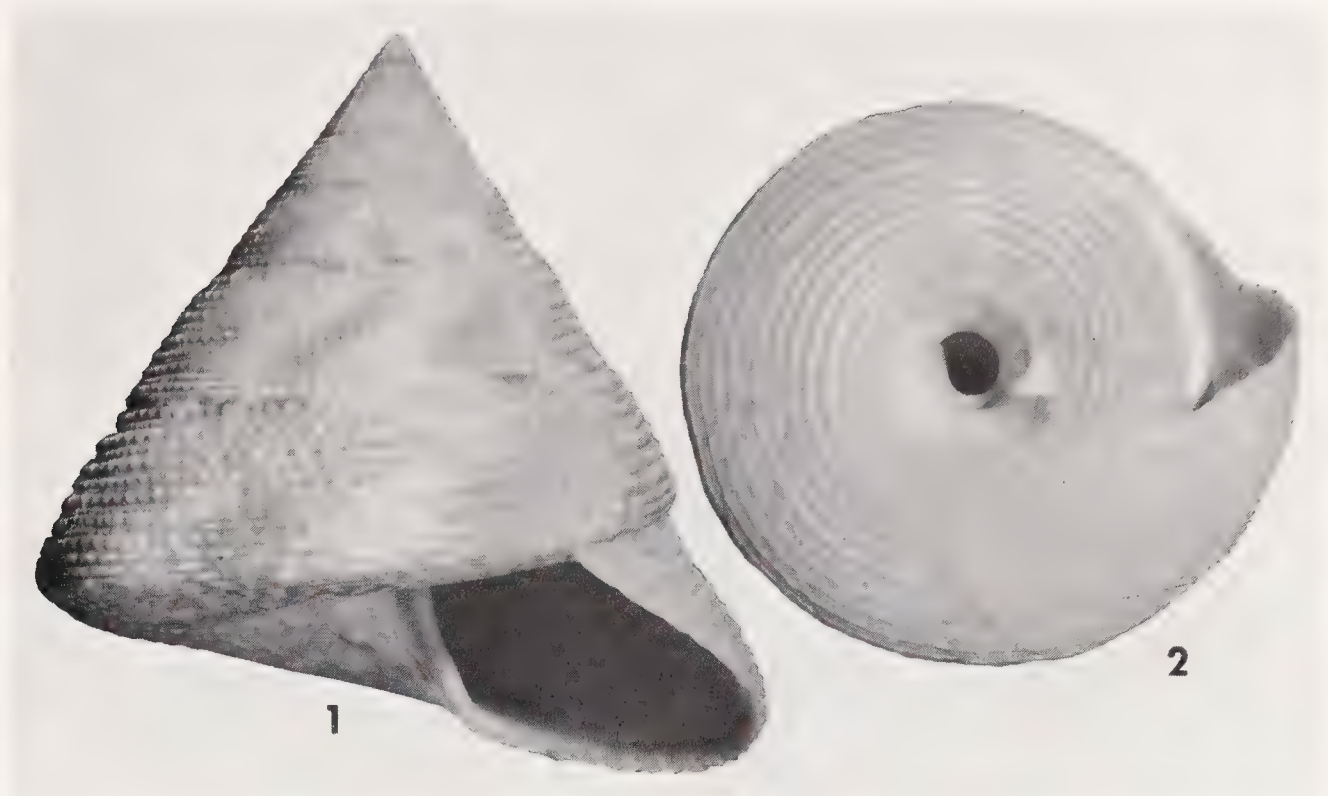


Plate 48. *Calliostoma hassler* Clench and Aguayo. Fig. 1. Hassler voyage, off Cabo Frio, Brasil. Holotype. Fig. 2. Basal view of a paratype from the same locality (both 2.5x).

***Calliostoma barbouri* Clench and Aguayo**
Plate 49, figs. 1-3

Calliostoma barbouri Clench and Aguayo 1946, Revista de la Sociedad Malacologia 4: 89, text figure (Arenas de la Chorrera, Habana, from sand dredged in 3-15 fathoms at Santa Fé, Cuba).

Description. Shell reaching 22.5 mm. (about 1 inch) in length, trochoid in shape, rather solid in structure, umbilicate and finely sculptured. Ground color a yellowish to reddish brown with a broad band of purplish brown above the periphery, base of the shell with the ground color only. Occasionally this purplish brown band is somewhat mottled. In addition, there are fine reddish spiral threads between the beaded cords. Whorls 10, flat sided, with a sharp peripheral keel. Spire moderately extended, slightly convex and produced at an angle of about 70°. Aperture subquadrate, the outer lip simple and cast at an angle of 60° from the base. Columella strongly arched, slightly thickened, white in color and with a slight truncation. Umbilicus profound, reddish brown in color, narrowly funnel-shaped and bordered by a beaded cord. Suture indistinct. Spiral sculpture consisting of numerous fine, beaded cords. Axial sculpture consists of very fine diagonal ridges between the cords. Beaded cords on the base are variable in number and size, the cords varying from 19 to 25. Operculum unknown.

length	width	
19.2 mm.	19.5 mm.	Holotype
21.5	23.4	Paratype
22.5	25	Arenas de la Chorrera, Habana, Cuba

Types. The holotype is in the Museum of Comparative Zoology, no. 178128, from Arenas de la Chorrera, Habana, Cuba, from sand dredged in 3 to 15 fathoms in the vicinity of Santa Fé, a short distance from Habana.

Remarks. The shell of *Calliostoma barbouri* is similar in appearance to that of *C. javanicum* Lamarek. It differs by being narrower, by having a dark mottled coloration and by having the base uniformly beaded throughout. The base of *C. javanicum* is smooth near the periphery while the beaded cords on the whorls are much stronger and more regularly developed than on *C. barbouri*. In addition, the funnel-shaped umbilicus of *C. barbouri* is brownish red, while it is white in *C. javanicum*. Both these species occur in the dredged sands at Habana, Cuba. See also *Remarks* under *C. hassler* Clench and Aguayo.

Range. Known only from the type locality.

Specimens examined. CUBA: All specimens so far known are from the Arenas de la Chorrera, Habana (MCZ; ANSP; C. J. Finlay; V. Condé).

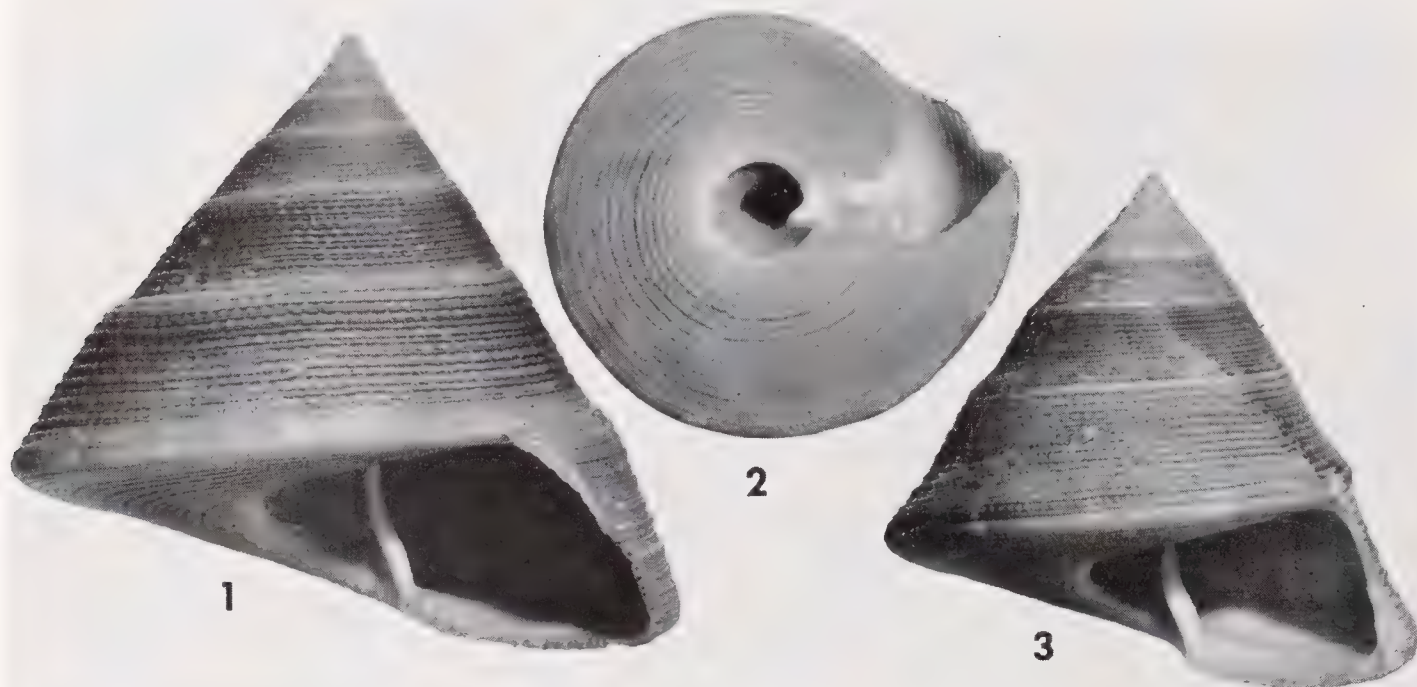


Plate 49. *Calliostoma barbouri* Clench and Aguayo. Fig. 1. Arenas de la Chorrera, Habana, Cuba. Fig. 2. Basal view of a specimen from the same locality. Fig. 3. Holotype from the same locality (all 2.7x).

Calliostoma sayanum Dall

Plate 50; figs. 1-3

Calliostoma (Eutrochus) sayanum Dall 1889, Bulletin Museum Comparative Zoology **18**: 370, pl. 33, figs. 10-11 (*Albatross*, station 2594, 20 miles SE of Cape Hatteras, North Carolina in 120 fathoms).

Description. Shell reaching 35 mm. (about $1\frac{3}{8}$ inches) in length, trochoid in shape, solid in structure, umbilicate and finely sculptured. Ground color a rich golden brown with a red band at the whorl periphery. Occasionally this band is diffused, rendering the whole shell somewhat reddish. Whorls $8\frac{1}{2}$, generally flat sided and with a rounded periphery. Base of shell slightly convex. Spire moderately extended, flat sided and produced at an angle of about 90° . Columella arched and somewhat thickened, ending in a truncation at the base of the lip. Aperture subquadrate, the outer lip simple and produced at an angle of 50° from the base. Umbilicus white, profound, smooth and margined by a strongly beaded cord. Sutures slightly indented and generally defined by the

red band. Sculpture consisting of numerous and finely beaded cords, about 15 cords on the base of the shell. Above the periphery the cords usually alternate large and small, and occasionally there are narrow bands of red between them. Microscopic sculpture consists of very fine diagonal growth lines. Operculum circular, multispiral, corneous, and having on the inner surface a papilliform nucleus.

length	width	
34 mm.	39 mm.	Holotype
31	38.5	75 miles E of St. Augustine, Florida
33.5	38.5	25 miles ESE of Cape Hatteras, North Carolina
33	39	" " " " " " " "

Types. The holotype of *Calliostoma sayanum* Dall is in the United States National Museum, no. 61240, from 20 miles SE of Cape Hatteras, North Carolina, *Albatross*, station 2594 (35°01' N; 75°12' W) in 160 fathoms, not 120 fathoms as given by Dall.

Remarks. This is a very attractive species. Unfortunately, most of the specimens we have seen were dead when collected though they were in very good condition. Our two southern records are based only on fragments. On the basis of shell characters this species appears to be most closely related to *C. springeri* Clench and Turner, but differs in having the sides of the spire straight rather than slightly concave and in having a much narrower umbilicus.

Range. From off Cape Hatteras, North Carolina to off Key West, Florida, ranging in depth from 65 to 200 fathoms.

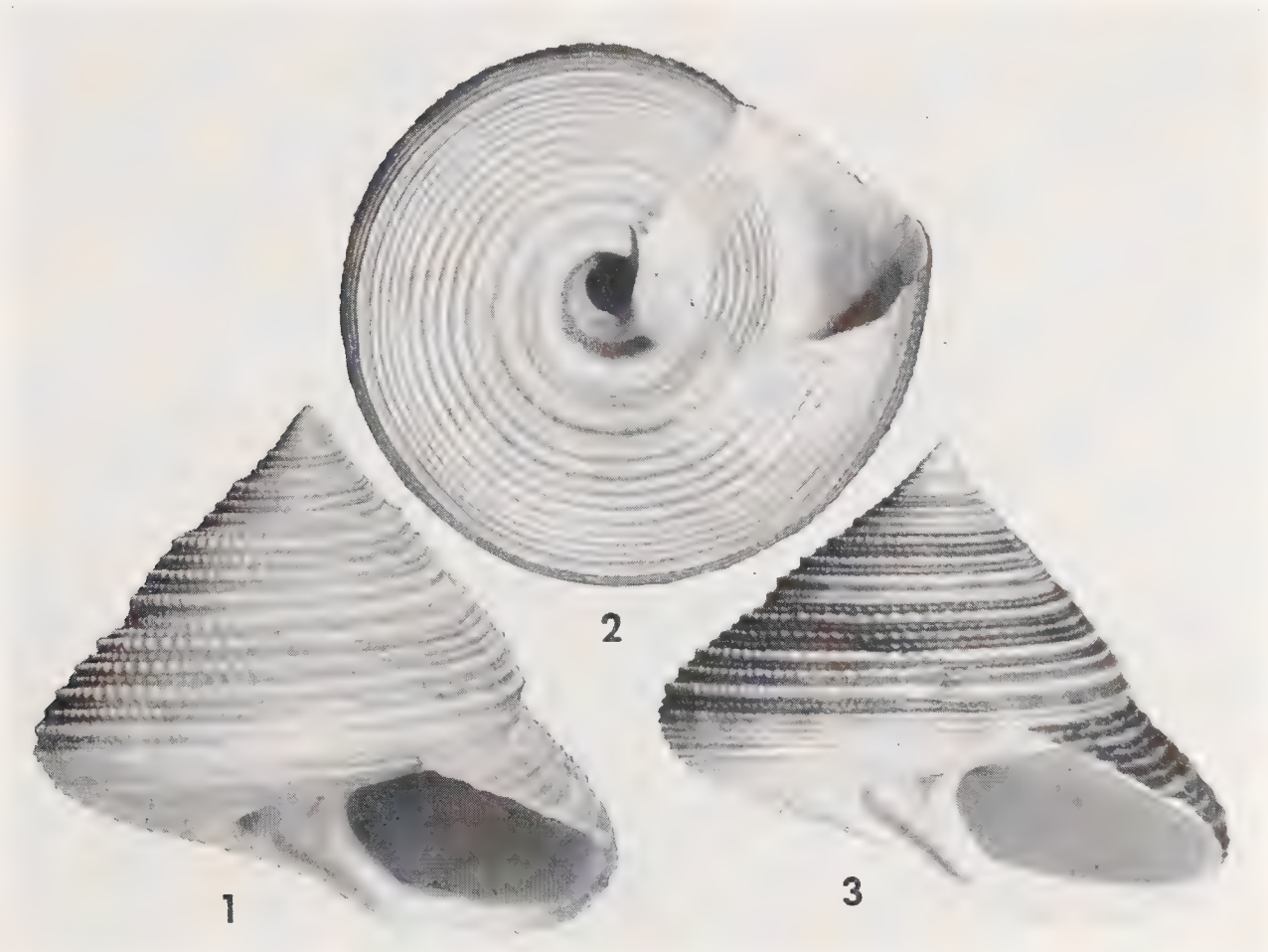


Plate 50. *Calliostoma sayanum* Dall. Fig. 1. 20 miles SE of Cape Hatteras, North Carolina. Holotype. Fig. 2. *Combat*, station 170, 23 miles ESE of Cape Hatteras, North Carolina. Fig. 3. *Combat*, station 499, 75 miles E of St. Augustine, Florida (all 1.6x).

Specimens examined. NORTH CAROLINA: *Albatross*, station 2594, about 20 miles SE of Cape Hatteras (35°01' N; 75°12' W) in 160 fathoms (USNM); *Combat*, station 170, about 23 miles ESE of Cape Hatteras (35°07' N; 75°04' W) in 190 fathoms (H. Bullis); *Albatross*, station 2601, about 35 miles S of Cape Hatteras (34°39' N; 75°33' W) in 107 fathoms (USNM). FLORIDA: *Combat*, station 79, about 70 miles E of St. Augustine (30°00' N; 80°14' W) in 110 fathoms; *Combat*, station 499, about 75 miles E of St. Augustine, (29°50' N; 80°10' W) in 200 fathoms (both H. Bullis); SE of Fernandina in 200 fathoms (T. McGinty); *Pelican*, station 70, about 50 miles ENE of Dayton (29°32' N; 80°08' W) in 190 fathoms (H. Bullis); off Melbourne in 90 fathoms (ANSP); off Palm Beach in 75 fathoms; off Sand Key Light, Key West in 65 fathoms (both T. McGinty); *Oregon*, station 1009, about 46 miles W of Tortugas (24°34' N; 83°34' W) in 200 fathoms (H. Bullis).

Calliostoma benedicti Dall

Plate 51

Calliostoma (Eutrochus) benedicti Dall 1889, Bulletin Museum Comparative Zoology **18**: 371, pl. 32, fig. 7 (off Cape Lookout, North Carolina in 200 fathoms).

Description. Shell reaching 14 mm. (about $\frac{1}{2}$ inch) in length, trochoid in shape, solid in structure, umbilicate and finely sculptured. Color a golden ivory, the cords white and the interspaces a golden yellow. Base of shell shiny white. Whorls 7, convex, with a rounded keel. Base of shell slightly convex. Spire depressed, slightly concave and produced at an angle of about 90°. Aperture suboval, the outer lip simple and produced at an angle of about 55° from the base. Columella rather thin, truncate and arched inwardly. Umbilicus white, rather narrow, and extending to the nuclear whorls. It is margined by a cord possessing very large beads. Suture slightly indented and rather indistinct. Sculpture consisting of spiral cords which may be smooth or beaded. On the body whorl there is a broad smooth cord at the periphery with 3 unequal, narrow, smooth cords immediately above. Above these cords there are 5 beaded cords, three larger cords alternating with two smaller cords. The earlier whorls have fewer cords. Microscopic sculpture consisting of exceedingly fine axial striae in the areas between the cords. Operculum circular, multispiral, corneous, and having on the inner surface a papilliform nucleus.

length	width	
14 mm.	17.5 mm.	Holotype

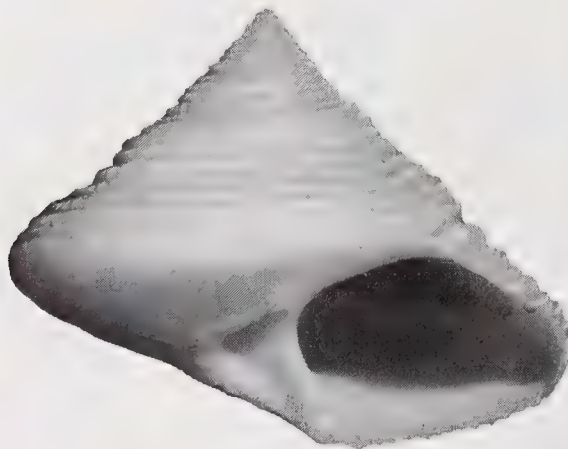


Plate 51. *Calliostoma benedicti* Dall. Off Cape Lookout, North Carolina. Holotype (about 3.2x).

Types. The holotype and only known specimen of *C. benedicti* Dall is in the United States National Museum, no. 61241, from off Cape Lookout, North Carolina in about 200 fathoms.

Remarks. On the basis of shell characters this species is closely related to *C. springeri* Clench and Turner, but differs in being much lighter in color, smaller in size, and in having a much narrower funicular umbilicus.

The following is taken from Dall's original account of *C. benedicti*. "It is named in honor of Mr. J. S. Benedict, former naturalist of the *Albatross* party, who rescued it from a pilfering and aesthetic sailor, by whose theft the exact station number was lost. It was living when obtained."

Range and Specimens examined. Known only from the type locality.

***Calliostoma springeri*, new species¹**

Plate 52, figs. 1-2

Description. Shell reaching about 30 mm. (about $1\frac{1}{4}$ inches) in length, trochoid in shape, rather solid in structure, umbilicate and finely sculptured. Color pattern consisting of white beaded cords interspaced with brownish red spiral bands. Whorls 9, flat sided and with a rounded periphery. Base of shell slightly convex. Spire moderately extended, slightly concave and produced at an angle of about 90° . Aperture subquadrate, the outer lip simple and produced at an angle of about 40° from the base. Columella arched, slightly thickened and ending in a truncation at the base of the lip. Umbilicus white, profound, smooth and margined by a non-beaded cord. Suture slightly indented and poorly defined. Sculpture consisting of numerous finely beaded cords above the periphery. Below the periphery these cords are much less strongly beaded, becoming smooth toward the umbilicus. There are 19-20 cords on the base of the shell. Micro-

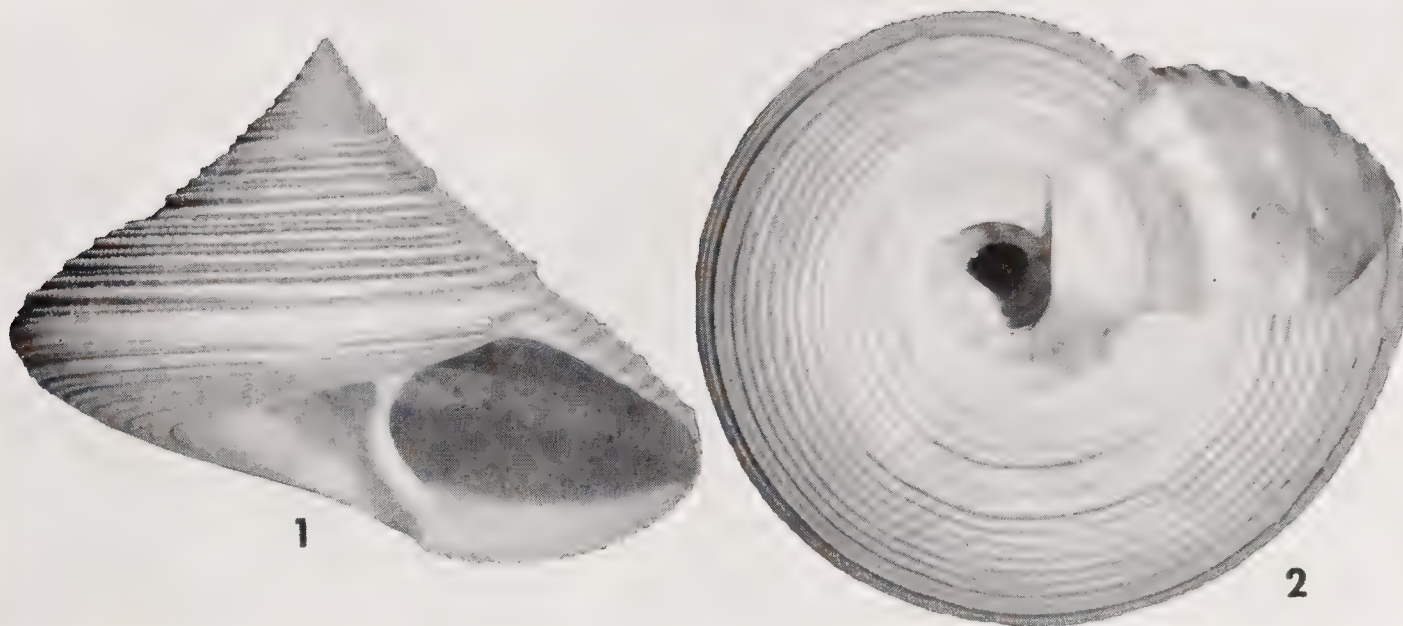


Plate 52. *Calliostoma springeri* Clench and Turner. Fig. 1. Oregon, station 1283, off the Mississippi Delta, 38 miles E of Southeast Pass ($29^\circ 06' N$; $88^\circ 19' W$) in 260 fathoms. Holotype. Fig. 2. Basal view of a paratype from the same locality (both 1.8x).

¹ Named for Stuart Springer, of the U.S. Fish and Wildlife Service and formerly Chief Naturalist of the M/V Oregon.

scopic sculpture consists of very fine diagonal growth lines. Operculum circular, multi-spiral, corneous and lacking a papilliform nucleus on the inner surface.

length	width	
30 mm.	38.4 mm.	Holotype
30.2	39	Paratype

Types. The holotype is in the United States National Museum, no. 612703, from about 38 miles east of Southeast Pass, Mississippi Delta, Louisiana. *Oregon*, station 1283 (29°06' N; 88°19' W) in 260 fathoms, March 13, 1955.

Remarks. This species is superficially close to *C. sayanum* Dall. It differs in having the cords on the base of the shell smooth or only very finely beaded. Above the periphery there is no color other than the brownish red threads between the cords, while in *sayanum* there is a peripheral color band of red and the beaded cords are colored a light brown. In addition, *springeri* has a golden iridescence but the surface of *sayanum* though highly colored is dull. The umbilicus of *springeri* is nearly twice as wide as that of *sayanum* when specimens of equal width are compared.

See also *Remarks* under *C. bigelowi* and *C. benedicti*.

Range and Specimens examined. This species is known only from the type locality.

Calliostoma bigelowi *Clench and Aguayo*
Plate 53, figs. 1-2

Calliostoma (Astele) bigelowi Clench and Aguayo 1938, *Memorias de la Sociedad de Historia Natural* 12: 378, pl. 28, figs. 4-5 (*Atlantis*, station 2963-C, off Bahía Cochinos, Las Villas, Cuba, 22°07' N; 81°08' W, in 205 fathoms).

Description. Shell reaching 25 mm. (about 1 inch) in length, depressed trochoid, keeled, fairly light in structure, widely umbilicate and finely sculptured. Ground color grayish white, with narrow spiral bands of brownish orange above the periphery. On the base of the shell there are numerous bands of the same color many of which have become somewhat diffused. At the periphery there is a band of flame-like markings of reddish brown which are more or less evenly spaced. Whorls $7\frac{1}{2}$, regularly increasing in size,



Plate 53. *Calliostoma bigelowi* Clench and Aguayo. Fig. 1. *Atlantis*, station 2963-c, off Bahía Cochinos, Las Villas, Cuba in 205 fathoms. Holotype (2x). Fig. 2. Basal view of the same specimen (2.1x).

convex and sharply keeled. Spire somewhat depressed, concave and produced at an angle of about 100° . Suture indistinct. Aperture subquadrate and nacreous within. Palatal wall thinly glazed. Columella thickened and arched toward the umbilicus. Umbilicus broadly funnel shaped and deep. The first three and one half postnuclear whorls sculptured with three minutely beaded cords. On the succeeding two whorls the cords are not beaded, then gradually the cords become increasingly beaded to the body whorl where they are pronounced. Base of the shell smooth, having only very fine growth lines. Operculum corneous, multispiral, with 10 whorls, crossed with numerous fine, somewhat sinuous growth lines.

length	width	
25 mm.	33.5 mm.	Holotype

Types. The holotype is in the Museum of Comparative Zoology, no. 135003, from the *Atlantis*, station 2963C, off Bahía Cochinos, Las Villas, Cuba ($22^\circ 07' N$; $81^\circ 08' W$) in 205 fathoms.

Remarks. This species is moderately close in its relationships to *C. springeri* Clench and Turner, but differs in having the base smooth without any indication of cords, in having a more deeply concave columella and in having the peripheral area marked with brown-red spots. Above the periphery the two species are similar in general outline and sculpture, though the beading on *C. bigelowi* is much weaker than on *C. springeri*. See also *Remarks* under *C. tejedori* Aguayo.

Range. Known only from the north and south coasts of Cuba.

Specimens examined. CUBA: *Atlantis*, station 2963C, Bahía Cochinos, Las Villas ($22^\circ 07' N$, $80^\circ 08' W$) in 205 fathoms; *Atlantis*, station 2999, off Matanzas, Matanzas Prov. ($23^\circ 10' N$; $81^\circ 29' W$) in 145–230 fathoms (both MCZ).

Calliostoma tejedori Aguayo

Plate 54, figs. 1–2

Calliostoma (Astele) tejedori Aguayo 1949; Revista de la Sociedad Malacologica "Carlos de la Torre" 6: 94, pl. 4, fig. 7 (Arenas de la Chorrera, Habana, Cuba).

Description. Shell reaching 22.5 mm. (about 1 inch) in length, depressed trochoid, keeled, fairly light in structure, widely umbilicate and nearly smooth. Color a light brownish orange with irregular and discontinuous patches of brown across the whorl periphery. Above the periphery there are three incised lines which are brown in color. The entire outer surface shiny but not iridescent. Whorls $8\frac{1}{2}$, strongly convex, with a rounded keel. Spire somewhat depressed, slightly concave and produced at an angle of about 90° . Suture slightly indented. Aperture subquadrate with the palatal lip thin and cast at an angle of about 50° from the base. Parietal wall thinly glazed. Columella thin, arched and truncated. Umbilicus broadly funnel-shaped, deep, and colored a reddish brown. Sculpture consists of a single large, smooth cord at the whorl periphery. Above the periphery there are numerous very fine incised lines, three of which are colored brown. Nuclear whorls and two postnuclear whorls reticulate, the fourth whorl with finely beaded cords. Remaining whorls sculptured as described for the body whorl above. Operculum unknown.

length	width	
22.5 mm.	32 mm.	Holotype

Types. The holotype of *C. tejedori* Aguayo is in the Muséo Poey, Universidad de la Habana, Cuba, no. 12389, from the Arenas de la Chorrera, Habana, Cuba.

Remarks. So far as we know this is the only species of *Calliostoma* in the Western Atlantic which has reticulated nuclear whorls. In relationship it appears to be nearest to *C. bigelowi* Clench and Aguayo because of its general shape and widely opened umbilicus, though this is not a close relationship. From *C. jeanneae* Clench and Turner, the only other nearly smooth *Calliostoma* in the Western Atlantic, it differs in being much larger and umbilicate.

Range and Specimens examined. Known only from the holotype specimen which was taken from the pile of construction sand at Habana, Cuba, known as the Arenas de la Chorrera. This sand is dredged in from 3 to 15 fathoms near Habana, Cuba.

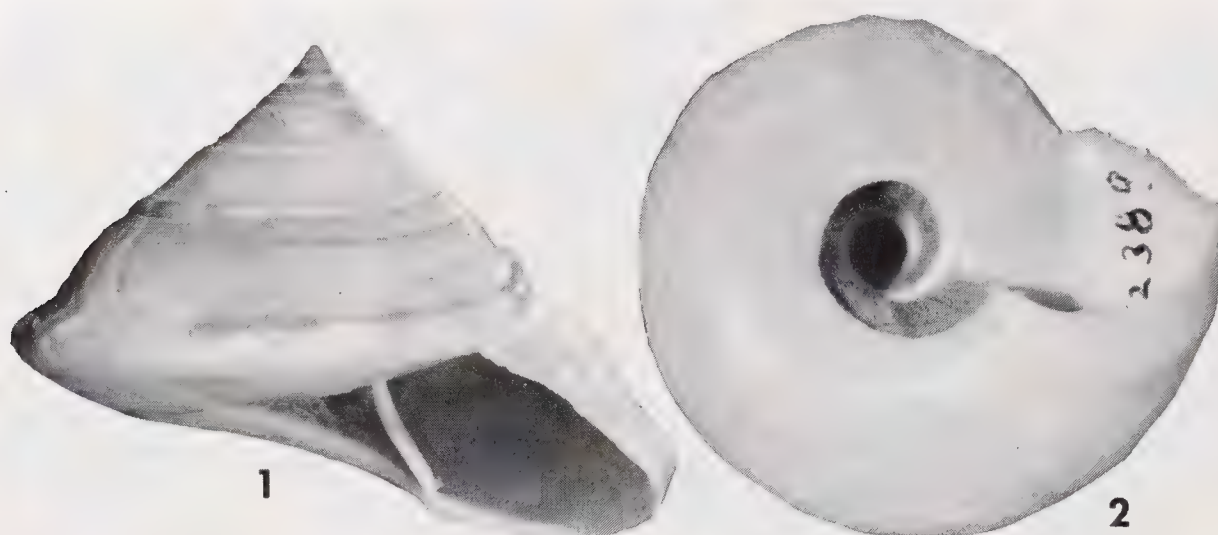


Plate 54. *Calliostoma tejedori* Aguayo. Fig. 1. Arenas de la Chorrera, Habana, Cuba. Holotype. Fig. 2. Basal view of the same specimen (both 2.2x).

Calliostoma gemmosum Reeve

Trochus gemmosus Reeve 1842, *Conchologia Systematica* 2: 165, pl. 218, fig. 9 (no locality given); 1842 [1843] *Proc. Zool. Soc. London*, p. 184 (locality unknown).

Zizyphinus gemmosus Reeve 1863, *Conchologia Iconica* 14, *Zizyphinus*, pl. 4, fig. 23 (Puerto Galero, Mindanao, Philippines).

Trochus (Eutrochus) gemmosus Reeve. Smith 1890, *Journal Linnean Society of London* 20: 494 (Fernando Noronha).

Calliostoma gemmosum Reeve. Lopes and Alvarenga 1955, *Boletim do Instituto Oceanográfico* 4: 163, pl. 2, figs. 18-19.

Description. Shell reaching 19 mm. (about $\frac{3}{4}$ inch) in length, trochoid, umbilicate and sculptured. Color yellowish straw lightly mottled with brownish and with a few reddish prominent spiral lines. Whorls 7 to 8, convex and with a flattened peripheral keel. Spire moderately extended and produced at an angle of about 67° . Aperture subquadrate and produced at an angle of about 45° from the base. Columella margined by a ridge and arched inwardly. Umbilicus deep and margined by a heavy cord with coarse beading. Suture inconspicuous. Sculpture consists of numerous rather fine beaded cords which are more or less equal in size. Nuclear whorl smooth and a brownish purple in color. Operculum unknown.

length	width	
14 mm.	15.5 mm.	Itapoan, Salvador, Baia, Brasil

Types. The location of the holotype of *Trochus gemmosus* Reeve is unknown (see under *Remarks*).

Remarks. This species was first figured in the *Conchologia Systematica* in 1842 without description. In 1843, in the *Proceedings of the Zoological Society of London* it was formally described and at that time the locality was stated to be unknown. The specimens were said to be in the Museum Stainforth. In 1863, Reeve, in the *Conchologia Iconica*, described and figured a species which he called *Zizyphinus gemmosus* from the Cuming Collection with the locality of Puerto Galero, Mindanao, Philippine Islands. J. Davy Dean (1936, p. 239) stated that the Stainforth Collection was sold at auction about 1860, but that he could give no further information about it. Sherborn (1940) does not mention the collection. It would appear then that the shell figured by Reeve in 1863 was not the same as that figured in 1842. The type locality still remains unknown. Smith (1890) listed the species as coming from Fernando Noronha, Brasil and stated that his specimens were identical with the 'types' in the British Museum. Obviously these were the specimens in the Cuming collection for he mentioned the Philippine locality and stated that he believed it was in error. Lopes and Alvarenga (1955) recorded and figured specimens from Itapoan, Salvador, Baia, Brasil which, following Smith, they referred to *gemmosum* Reeve. Certainly Lopes' specimens are different from any other we have from the Western Atlantic and the figure of Lopes and Alvarenga as well as the rather poor specimen which we have seen do agree with the description and figure of Reeve. In all probability the locality given in the *Conchologia Iconica* is wrong and this is a Western Atlantic species. However, it is really necessary to obtain more material from both the Atlantic and the Pacific before it will be possible to say definitely that there are not two species involved and that *gemmosum* is from the Brazilian area. This is particularly true since the location of the Stainforth specimens is unknown.

We have seen only a single dead and faded specimen of this Brazilian species and are tentatively calling it *Calliostoma gemmosum* Reeve as this name, as shown above, has been used for it by two authors.

In relationship, based on shell characters only, it appears to be close to *C. javanicum* Lamarck, differing by being smaller, having more complex whorls and in not having a straight-sided spire. The sculpturing is similar except that it is more pronounced on *gemmosum*, particularly so on the base of the shell.

Range. The island of Fernando Noronha and Est. Baia, Brasil.

Specimens examined. BRASIL: Itapoan, Salvador, Est. Baia (H. deS. Lopes).

***Calliostoma militaris* von Ihering**

Calliostoma militaris von Ihering 1907, *Anales Museo Nacional de Buenos Aires* (3) 7: 438, pl. 17, fig. 116 (Necochea, Argentina).

Calliostoma dalli von Ihering 1907, *Anales Museo Nacional de Buenos Aires* (3) 7: 437, pl. 17, figs. 114a-c (Pampienne Formation, Deseado, Argentina).

Calliostoma militaris von Ihering. Carcelles 1944, *Revista del Museo de la Plata* (n.s.) Zoologia 3: 240.

Remarks. We have not seen specimens of this species and the figures of both *militaris* and *dalli* given by von Ihering are too poor to reproduce. It appears to be a very rare

species and is known only from the area extending from Necochea south to Río Negro, Argentina. We have followed the work of Carcelles in the above synonymy. Until material is available for study we cannot deal further with this species.

* * * *

Notes

The following section includes references to and comments concerning subgenera and species which have been referred to *Calliostoma* in the Western Atlantic. Some are placed in other genera but in several cases we have made no attempt to assign them to a genus. Many were based upon dead and broken specimens and some were immature.

Subgenus *Astele* Swainson

Astele Swainson 1855, Papers and Proc. Royal Soc. Van Diemen's Land **3**: 38.

Eutrochus A. Adams 1863 [1864], Proc. Zool. Soc. London, p. 506 [Type species, *Eutrochus perspectivus* A. Adams (= *Astele subcarinata* Swainson) monotypic].

Type species, *Astele subcarinata* Swainson, monotypic.

Shells, so far as known, umbilicate, marked with patches of brown or red-brown and sculptured with smooth and beaded cords. Aperture subquadrate.

Radula with the central tooth having a long, narrow, denticulate cusp. The four lateral teeth have a large plate-like base and long narrow cusps which are denticulate only at their distal ends. The first marginal tooth is very broad and heavy with a large denticulate cusp and a small cusp on the base. The other marginal teeth are fairly uniform, long, narrow and denticulate at their distal ends. They decrease somewhat in length toward the outer margin of the ribbon and vary in number, averaging about 20.

Jaws rather heavy, dark brown in color, subcircular in outline with the anterior ends broadly rounded, smooth and lacking a fringe.

Calliostoma (Astele) subcarinatum Swainson

Plate 55, figs. 1-2; Plate 56, figs. 1-2

Astele subcarinata Swainson 1855, Papers and Proc. Royal Soc. Van Diemen's Land **3**: 38, pl. 6, figs. 1-2 (Tasmania).

Eutrochus perspectivus A. Adams 1863 [1864] Proc. Zool. Soc. London, p. 506 (Tasmania); non *perspectivus* Philippi 1843.

Zizyphinus subgranularis Dunker 1871, Malakozoologische Blätt. **18**: 170 (Bass Strait, Australia).

Calliostoma (Eutrochus) adamsi Pilsbry 1890, Manual of Conchology (1) **11**: 402 [new name for *Eutrochus perspectivus* A. Adams 1864, non Philippi 1843].

Calliostoma subgranulatum 'Dunker' Pilsbry 1890, Manual of Conchology (1) **11**: 403 (Bass Strait, Australia) [error for *C. subgranularis* Dunker].

Astele subcarinatum Swainson. Cotton 1959, South Australian Mollusca, Part III, Archeogastropoda, Adelaide, South Australia, p. 145, text figure 79.

Description. Shell reaching 34 mm. (about 1½ inches) in length, trochoid in shape, rather light in structure, widely umbilicate and coarsely sculptured. Color a light ivory-yellow with faint irregular patches of brown and tinges of lavender on living specimens. Whorls 9, very flat sided with a pronounced keel at the whorl periphery. Spire moderately extended and produced at an angle of about 70°. Aperture subquadrate, outer lip

simple and produced at an angle of about 45° from the base. Columella slightly arched and truncated at the base. Umbilicus rather wide, deep and margined with 2 or 3 beaded cords. Suture indistinct, but indicated by the presence of a large beaded cord. Sculpture consisting of 8 to 11 spiral cords on the body whorl above the periphery. These cords vary in size, and the uppermost, which is the largest, is generally beaded while the remainder are smooth. Below the periphery there are 12 to 14 cords. The two or three cords margining the umbilicus are beaded, the others are smooth. Operculum circular, corneous, thin, multispiral and colored a light yellowish brown. Nuclear whorls $1\frac{1}{2}$, white and smooth.



Plate 55. *Calliostoma (Astele) subcarinatum* Swainson. Fig. 1. Tasmania. Fig. 2. Gulf of St. Vincent, South Australia (both about 1.7x).

length	width	
34 mm.	37 mm.	Tasmania
28	33	about 11 miles E of Baronda Head, New South Wales, Australia
26	30.5	Gulf of St. Vincent, South Australia

Types. The location of the type specimen of *Astele subcarinata* Swainson is unknown; the type locality is Tasmania. The holotype *E. perspectivus* A. Adams is probably in the British Museum; the type locality is Tasmania. The location of the type of *Zizyphinus subgranularis* Dunker is unknown.

Remarks. We have described this species in full as it is the type species for the subgenus *Astele*. This subgenus, either as *Astele* or *Eutrochus*, has been used for umbilicate Western Atlantic species, but so far as we now know, no species in this subgenus occurs in the Western Atlantic. Its relationship to other Indo-Pacific *Calliostoma* will remain uncertain until the anatomy of the various species of the Australian region is known.

Range. New South Wales and Tasmania west to Western Australia and ranging in depth from 16 to 200 fathoms according to Allen, 1950, p. 62.

Specimens examined. NEW SOUTH WALES: about 11 miles E of Baronda Head ($150^\circ 12' \text{ E}$; $36^\circ 40' \text{ S}$) (H. Macpherson). SOUTH AUSTRALIA: Gulf of St. Vincent in 17 fathoms (B. C. Cotton). TASMANIA: East Tasmania (MCZ; Australian Mus.).

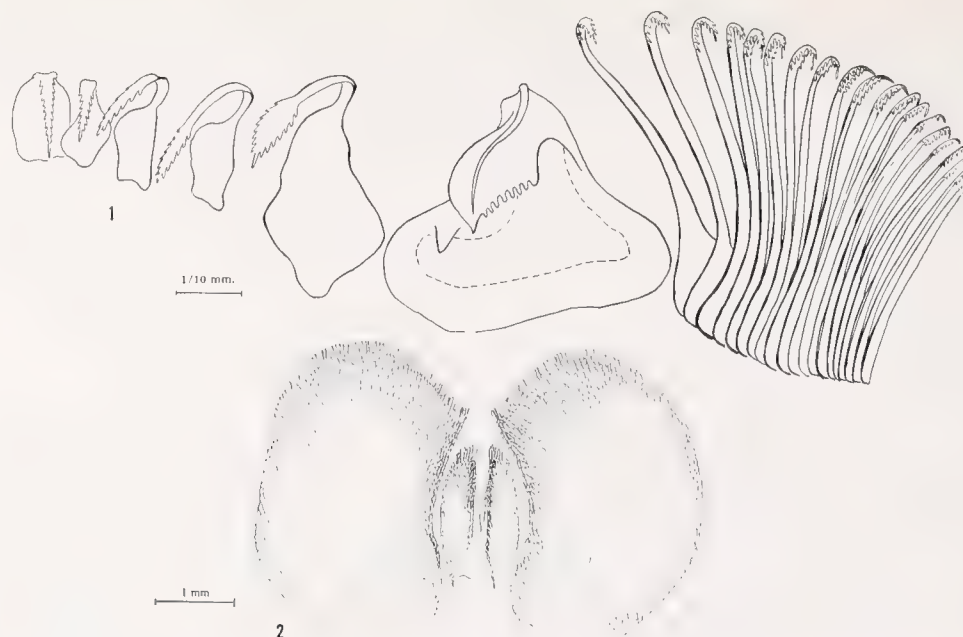


Plate 56. *Calliostoma (Astele) subcarinatum* Swainson. Fig. 1. Radula showing the greatly enlarged first marginal tooth and the dissimilar lateral teeth. All marginal teeth are included. Fig. 2. Jaws, partially reconstructed, showing the rounded anterior end and the narrow fringe. Only a portion of the scales on the surface of the jaws is indicated.

Genus *Alertalex* Dell

Alertalex Dell 1956, Bull. Dominion Museum, Wellington, New Zealand, no. 18, p. 46.

Type species, *Alertalex blacki* Dell, original designation.

Dell instituted this genus for a New Zealand species which we believe belongs to *Calliostoma* s.s. Unfortunately the jaws were not figured, nor were the bases of the marginal teeth of the radula, but the shape of the lateral teeth and the upper portion of the two innermost marginals as well as his written description of the radula appear to be very similar to the figures shown on our plates 3 and 4 for species belonging to *Calliostoma* s.s.

Dell related his species among others to *C. coppingeri* Smith which is a member of the subgenus *Calliostoma*. (See page 26, plate 18.)

Genus *Solariella* S. V. Wood

Solariella S. V. Wood 1842, Annals and Magazine of Natural History **9**: 531.

Type species, *Solariella maculata* S. V. Wood, monotypic.

Solariella tiara Watson

Trochus (Zizyphinus) tiara Watson 1879, Journal Linnean Society London **14**: 696; Watson 1885, Report of the Voyage of the HMS Challenger **15**: 60, pl. 6, fig. 4 (*Challenger*, station 24, off Culebra Island, West Indies, 18°38'30" N; 65°5'30" W, in 390 fathoms).

Calliostoma tiara Watson. Dall 1889, Bull. Museum Comparative Zoology **18**: 365.

Subgenus *Dentistyla* Dall

Dentistyla Dall 1889, Bull. Museum Comparative Zoology **18**: 373.

Antillachelus Woodring 1928, Carnegie Institution of Washington Pub. no. 385, p. 433 (type species, *Calliostoma (Dentistyla) asperimum* var. *dentiferum* Dall, original designation).

Type species, *Margarita asperima* Dall, subsequent designation, Woodring 1928.

Dentistyla was introduced by Dall as a subgenus in *Calliostoma*, but in our opinion it should be placed as a subgenus in *Solariella*.

***Solariella* (*Dentistyla*) *asperrima* Dall**

Margarita asperrimum Dall 1881, Bull. Museum Comparative Zoology **9**: 40 (*Blake*, station 12, west of Tortugas, Florida, $24^{\circ}34'$ N; $83^{\circ}16'$ W, in 36 fathoms [not 177 fathoms as given by Dall]).

Calliostoma (*Dentistyla*) *asperimum* Dall 1889, Bull. Museum Comparative Zoology **18**: 373.

Dentistyla asperrima Dall. Woodring 1928, Carnegie Institution of Washington Pub., no. 385, p. 430.

Antillachelus vaughani Woodring, which he describes as having "a much smaller columellar tooth" than *dentiferum* Dall, is probably this species. The type specimens of *asperrimum* do show a small tooth on the columella.

***Solariella* (*Dentistyla*) *dentifera* Dall**

Calliostoma asperrimum var. *dentiferum* Dall 1889, Bull. Museum Comparative Zoology **18**: 373, pl. 23, figs. 7-8 (*Blake*, station 299, off Barbados, Lesser Antilles, $13^{\circ}05'$ N; $59^{\circ}39'40''$ W, in 140 fathoms).

Antillachelus dentiferum Dall. Woodring 1928, Carnegie Institution of Washington Pub. no. 385, p. 433.

This species is the type of *Antillachelus* Woodring which we consider a synonym of *Dentistyla*. The characters mentioned by Woodring are certainly of no more than specific value. There is a small tooth on the columella of *asperrima*, and the lirae within the aperture of the unique specimen of *dentiferum* is a juvenile character. These "lirae" are nothing more than the spiral cords which show through on the young specimen before the shell is sufficiently thickened.

***Solariella* (*Dentistyla*) *sericifila* Dall**

Calliostoma (*Dentistyla*) *sericifilum* Dall 1889, Bull. Museum Comparative Zoology **18**: 373, pl. 24, figs. 1-1a (*Blake*, station 262, off Grenada, $12^{\circ}01'45''$ N; $61^{\circ}47'25''$ W, in 92 fathoms).

Subgenus *Mirachelus* Woodring

Mirachelus Woodring 1928, Carnegie Institution of Washington Pub. no. 385, p. 434.

Type species, *Calliostoma corbis*, Dall, original designation.

***Solariella* (*Mirachelus*) *corbis* Dall**

Calliostoma corbis Dall 1889, Bull. Museum Comparative Zoology **18**: 365, pl. 33, fig. 1 (off Habana, Cuba in 450 fathoms and off Bahia Honda, Cuba in 220 fathoms).

* * * *

The following species which were originally described as *Calliostoma* we feel do not belong in this genus. These we are unable to assign to a genus without much additional study.

arestum Dall, *Calliostoma* 1927, Proc. United States National Museum **70**: 127 (*Albatross*, station 2415, about 123 miles east of Fernandina, Florida, $30^{\circ}44'$ N; $79^{\circ}26'$ W, in 440 fathoms). Holotype, USNM 108412.

blakei Clench and Aguayo, *Calliostoma* (*Calliostoma*) 1938, Memorias de la Sociedad Cubana de Historia Natural **12**: 376, pl. 28, fig. 6 (*Hassler* voyage, off Cape Bermeja, Argentina, $41^{\circ}17'$ S, in 17 fathoms). Holotype MCZ 89661.

[Is probably in the genus *Photinula*.]

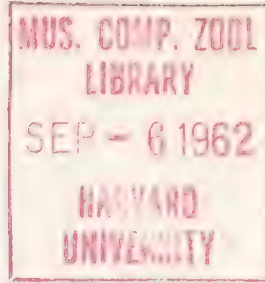
- cinctellum** Dall, **Calliostoma (Eutrochus)** 1889, Bull. Museum Comparative Zoology **18**: 372, pl. 32, figs. 1-4 (*Blake*, station 101, off Habana, Cuba in 174 fathoms). Holotype USNM 214274.
[Is probably in the genus *Basilissa*.]
- circumcinctum** Dall, **Calliostoma** 1880, Bull. Museum Comparative Zoology **9**: 44 (*Blake*, station 2, off Habana, Cuba, $23^{\circ}14' N$; $82^{\circ}25' W$, in 805 fathoms); Dall 1889, Bull. Museum Comparative Zoology **18**: 364, pl. 22, figs. 3-3a. Holotype MCZ 7558.
- halibrectum** Dall, **Calliostoma** 1927, Proc. United States National Museum **70**: 127 (*Albatross*, station 2668, about 107 miles east of Brunswick, Georgia, $30^{\circ}58' N$; $79^{\circ}38' W$, in 294 fathoms). Holotype USNM 108126.
- kampsia** Dall, **Calliostoma** 1927, Proc. United States National Museum **70**: 128 (*Albatross*, station 2415, about 123 miles east of Fernandina, Florida, $30^{\circ}44' N$; $79^{\circ}26' W$, in 440 fathoms). Holotype USNM 108423.
- tittarium** Dall, **Calliostoma** 1927, Proc. United States National Museum **70**: 127 (*Albatross*, station 2415, about 123 miles E of Fernandina, Florida, $30^{\circ}44' N$; $79^{\circ}26' W$, in 440 fathoms) [Lectotype, here selected USNM 108417].
- trachystum** Dall, **Calliostoma** 1927, Proc. United States National Museum **70**: 128 (*Albatross*, station 2415, about 123 miles E of Fernandina, Florida, $30^{\circ}44' N$; $79^{\circ}26' W$, in 440 fathoms). Holotype USNM 108419.

REFERENCES

- Allan, Joyce 1950. Australian Shells. Sydney, Australia, pp. 57-66.
- Carcelles, A. and J. J. Parodiz 1938. Moluscos del Contenido Estomacal de "*Astropecten cingulatus*" Sladen. *Physis* **12**: 251-266.
- Cotton, B. C. 1959. South Australian Mollusca—Archaeogastropoda. Adelaide, South Australia, pp. 145-152.
- Dall, W. H. 1889. Report on the Blake Mollusca. Bull. Mus. Comp. Zool. **18**: 363-374.
- Dall, W. H. 1892. Trans. Wagner Free Inst. Science, Philadelphia **3**: 390-406.
- Dall, W. H. 1897. List of Species Collected at Bahia, Brazil by H. von Ihering, *Nautilus* **10**: 123.
- Dean, J. Davy 1936. Conchological Cabinets of the Last Century. *Journal of Conchology* **20**: 225-252.
- Dell, R. K. 1956. The Archibenthal Mollusca of New Zealand. Bulletin Dominion Museum, Wellington, New Zealand, no. 18, pp. 45-49, figs. 61, 120, 260, Plate A, fig. 8.
- Gersch, M. 1936. Der Genitalapparat und die Sexualbiologie der Nord See Trochiden. *Zeitschrift für Morphologie und Ökologie der Tiere* **31** (1) 106-150, figs. 1-21.
- Ihering, H. von 1907. *Anales Museu Nacional de Buenos Aires* (3) **7**: 437-441.
- Jeffreys, J. G. 1865. *British Conchology* **3**: 330-336.
- Johnson, R. I. 1949. Jesse Wedgewood Mighels. Occasional Papers On Mollusks, Harvard University **1**: 213-232.
- Lebour, M. 1936. Notes on the Eggs and Larvae of Some Plymouth Prosobranchs. *Journal of the Marine Biological Association United Kingdom* (NS) **20**: 547-565, pls. 1-3.
- Lebour, M. 1937. The Eggs and Larvae of the British Prosobranchs with Special Reference to those Living in the Plankton. *Journal of the Marine Biological Association United Kingdom* (NS) **22**: 105-166, text figs. 1-4.
- Philippi, R. A. 1846-1855. *Conchylien-Cabinet* (2) **2**: pt. 3, pp. 1-372, pls. 1-49.
- Pilsbry, H. A. 1890. *Manual of Conchology* (1) **11**: 332-413.
- Reeve, L. 1863. *Conchologia Iconica* **14**, *Zizyphinus*, pls. 1-8, figs. 1-65.
- Robert, A. 1902. Recherches sur le Developpement des Troques. *Arch. de Zoologie Experimental Gen.* (3) **10**: 269-538, pls. 12-42. [Reprint repaged 1-270 and published in 1903.]
- Sherborn, C. D. 1940. Where is the ——— Collection? Cambridge, England, pp. 1-148.
- Shimer, H. W. and R. R. Shrock 1944. Index Fossils of North America. John Wiley & Sons, New York, p. 480, pl. 197.
- Thiele, J. 1929. *Handbuch der Systematischen Weichtierkunde* **1**: 49-56.
- Staad, J. L. 1956. Observations on the Subgeneric Classification of *Calliostoma*. *Jour. de Conchy.* **96**: 119-120.
- Wenz, W. 1938. *Handbuch der Palaozoologie. Gastropoda* **6**: Teil 2, pp. 269-287.
- Woodring, W. P. 1928. Miocene Mollusks from Bowden, Jamaica. Carnegie Institute of Washington Publication no. 385, pp. 427-437.

JOHNSONIA

Published by
THE DEPARTMENT OF MOLLUSKS
Museum of Comparative Zoölogy, Harvard University
Cambridge, Massachusetts



SEPTEMBER 7, 1962

MYTILIDAE

VOL. 4, NO. 41

THE GENUS LITHOPHAGA IN THE WESTERN ATLANTIC

BY

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The lithophages are a specialized group of marine bivalves belonging to the family Mytilidae which are adapted for boring into calcareous rocks, coral, and shells. They are often referred to as datte-de-mer, date shells, or sea dates, because the common species found in the Mediterranean is smooth, dark brown in color, and the shape of a date.

Though the lithophages are not of great economic importance they do occasionally cause damage to jetties, intake tunnels, and similar structures constructed of a poor grade of cement having a high calcareous content. Occasionally, man in his pursuit of the

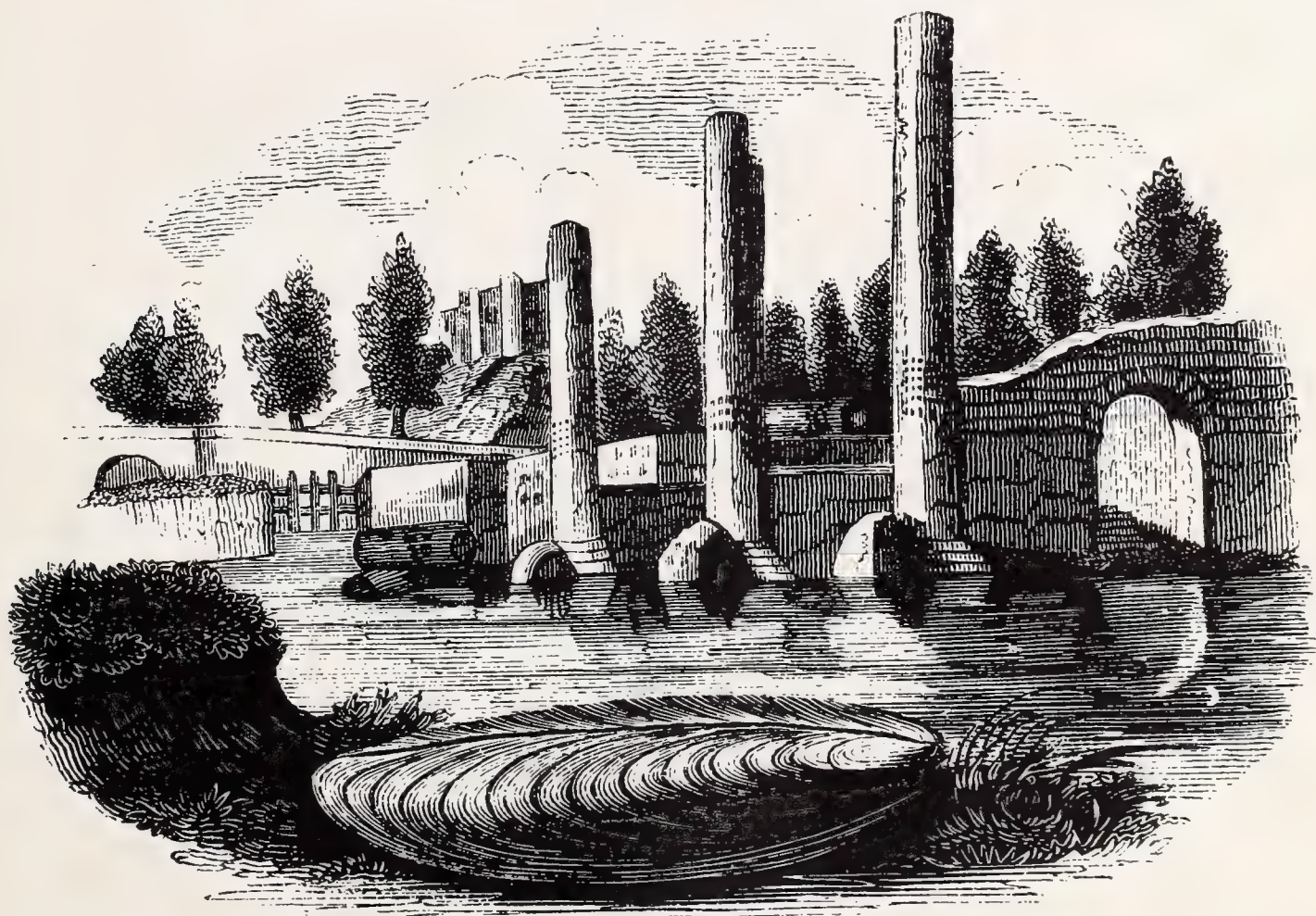


Plate 57. The Temple of Jupiter Serapis, near Pozzuolo, Bay of Naples, Italy, showing the three columns which were bored by *Lithophaga lithophaga* Linné when the temple was submerged. (From Johnston 1850, p. 150, fig. 26.)

datte-de-mer, which in Algiers is considered the most delicious of the many types of sea food, has been more destructive than the clam he sought. Dr. J. C. Bequaert informs us that when he was in Algiers in 1910, the local authorities had to prohibit the collecting and sale of the datte-de-mer lest the breakwater of the port be demolished by the collectors. [See also Remarks under *Lithophaga lithophaga* Linné.]

The boring of *Lithophaga lithophaga* Linné into the pillars of the so-called Temple of Jupiter Serapis¹ has afforded the geologists, notably Lyell, with an example of diastrophism. This ancient Roman ruin (Plate 57), situated in the Bay of Naples near the village of Pozzuolo, Italy has had an interesting history. The exact date of its construction is not known, but sometime during the early centuries of the first millenium, the site was inundated by the sea. Evidence for the eustatic change of the sea level but mainly the sinking and subsequent elevation of the land and the deposition of sediments is seen in the three remaining columns. Lyell has discussed exhaustively the geological events which were necessary to give us this example of the activity of *Lithophaga*. At the height of ten feet above the presently exposed plinths of these pillars, and in a position exactly corresponding in all, is a zone six feet in height where the marble has been penetrated by the Mediterranean species, *Lithophaga lithophaga*. Bodhatch (1761) and Spallanzani (1809) were among the earliest to detect and describe the occurrence of the lithophagous animals in these pillars. The holes made by the *Lithophaga* penetrate to a depth of nearly four inches, and according to Johnston (1850, p. 150) objects of a noncalcareous nature, such as quartz or feldspar, were by-passed and not penetrated at all.

In Japan, holes made by *Lithophaga nasuta* Philippi are used as indicators of old beach lines. The cliff walls near Misaki are studded with hundreds of holes arranged in parallel bands which are about a half meter in width and spaced a few meters apart. A series of earthquakes raised one band after another from the tide level well above high water mark, and the holes remain as evidence of the borers' former activity (Imamura, 1926).

Methods of Boring

Unlike other boring bivalves such as members of the specialized families Pholadidae, Teredinidae, and Petricolidae which use their shells as 'tools' in boring, the lithophages penetrate into the substrate by means of a chemical process. The exact nature of the chemical mechanisms behind this process is unknown. As early as 1846, Osler had made a study of boring bivalves and had concluded that either a chemical, a mechanical, or a combination of the two methods were employed by the various groups of boring mollusks. With a special interest in the method of boring of *Lithophaga*, numerous workers have attempted to adduce concrete evidence to support the hypothesis that acid secretion is the process behind the successful adaptation of *Lithophaga* to its peculiar habitat. List (1902), Carazzi (1903), and Pelseneer (1911) have suggested that particular glands, some of which are located along the margin of the mantle, are responsible for the secretion of an acid mucus. Following the procedure of Carazzi, Kühnelt (1930) in an exhaustive study tested the tissues of the animal with litmus paper. Though the presence of acidic conditions were detected, nothing concerning the concentrations of free acid could be discovered.

¹ Recent archeological investigations have proved that these ruins were not the remains of a temple, called by numerous authors, the Temple of Jupiter Serapis. It has been shown conclusively that the building was actually a market place (Longwell, 1951).

Kühnelt and, more recently, Hodgkin (1961) have presented excellent inferential evidence in support of the chemical method hypothesis. Using the Eastern Pacific subspecies, *Lithophaga plumula kelseyi* H. and S., Hodgkin experimented with argillaceous and calcareous substrates and showed that this species is unable to bore in noncalcareous media. Observing living animals of the same species, Yonge (1955) found that the fused anterior margins of the inner muscular lobe of the mantle can be protruded for some distance around the anterior end of the valves (see Plate 58). This extensible tissue, he observed, was applied to the anterior end of the burrow and when withdrawn had very fine granular particles embedded in the mucus covering it. Yonge also showed that this area of the mantle was ciliated and that the material was carried by currents in mucus strings ventrally into the mantle cavity and thence posteriorly to be expelled through the incurrent siphon as pseudofaeces.¹ According to Yonge, during the boring process it is necessary that the protruded mantle tissue be closely appressed against the anterior end of the burrow. The byssal threads attach the animal firmly to the substrate, and by the contraction of the posterior byssal retractor muscle, the valves are forced anteriorly. The contraction of the anterior byssal retractor moves the valves posteriorly when the animal is not actively boring. This action lengthens the burrow. The diameter is increased by the relaxation of the adductor muscles and the resulting forceful opening of the valves by the strong ligament. The posterior end of the burrow is probably enlarged by the secretions from the posterior gland and the action of the ligament.

Berry (1907), Amemiya (1923), and Haas (1942) have reported the occurrence of lithophages in noncalcareous substrates. We have seen specimens collected by J. Q. Burch off Monterey in 40 fathoms which were embedded in a rock substrate resembling shale, but a simple acid test revealed the presence of calcium carbonate. We assume that the 'blue hard clay' from Monterey mentioned by Berry (1907) may be of a similar chemical constitution. Through the kindness of Dr. Haas, we have had the opportunity to study the specimen upon which were based the remarks in his paper of 1942. A simple acid did not indicate the presence of calcium carbonate, but the material was shown to be a firm silt, composed largely of silt-sized particles of feldspar, quartz, and mica. Dr. Marlin Billings of the Department of Geology of Harvard referred to it as a dried mud, which when wet would be of a soft consistency. A small piece removed from the specimen completely disintegrated when placed in water. It would therefore appear that, though this firm mud is an unusual habitat for *Lithophaga*, there is no great problem concerned with the method of boring.

Unfortunately, it was after Dr. Haas' material had been returned that we received from

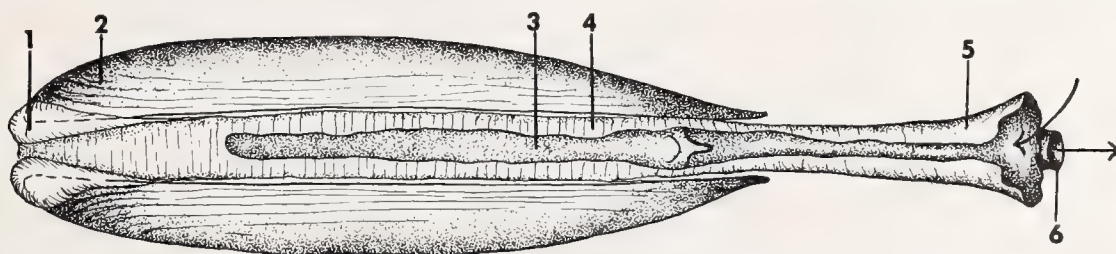


Plate 58. Ventral view of *Lithophaga plumula* Hanley showing the mantle extended over the anterior end of the valves. 1. Extension of the mantle over the shell. 2. Shell. 3. Mantle cavity. 4. Velum fold of the inner lobe of the mantle. 5. Incurrent siphon. 6. Excurrent siphon. (After Yonge, 1955.)

¹This process of cleaning the mantle cavity found in most bivalves is accomplished by a reverse muscle action of the incurrent siphon.

John Fitch a piece of hard rock from near Rocky Point, Lunada Bay, Palos Verdes, Los Angeles County, California from which we extracted five young specimens of *Lithophaga plumula* Hanley. Also boring into the rock were specimens of *Penitella penita* Conrad. When a drop of hydrochloric acid was applied to the rock, it appeared to have no effect; however, when the specimen was viewed microscopically, minute bubbles could be seen. A microscopic thin-section examination and an X-ray analysis of the rock by Professors Billings and Siever of the Geology Department showed it to be a rock dolomite which was 90% lime magnesium carbonate with a grain size of 0.04 mm. According to the engineer's scale this was a hard rock, 'solid with a ringing sound when struck with a hammer.' It was interesting to note that the rock around the opening of the *Lithophaga* burrows was sufficiently softened so that the aperture could be enlarged by picking with a dental tool while that around the aperture of the *Penitella* was not so affected and could not be enlarged. It is possible that Haas' specimen if examined microscopically would have also shown bubbles when acid was applied. Various reports have indicated that lithophages occur in sandstone, but invariably upon chemical testing the particles of sand have been found to be cemented together by calcium carbonate. As stated by Hodgkin (1961), the exact nature of the chemical process is unknown, but future experimental endeavors should indicate that either a free acid secretion or some ionic exchange mechanism is the responsible factor in the remarkable adaptation of *Lithophaga* to the rock-boring habit. It should be remembered that given time and constant application even a weak acid is capable of corroding a hard calcareous substrate, and such appears to be the case with *Lithophaga*.

The experimental results of Kühnelt, Hodgkin, and Yonge show that the method of boring is chemical and the records of lithophages in firm muds or clays show that at times they invade unusual substrates. *Lithophaga* have a free swimming veliger and a diligent search of various substrates would probably reveal young *Lithophaga* in a wide variety of places, most of them being unsuitable, so that the animal, unable to bore or to have some kind of protection, dies at a young stage. In fact, we have received specimens which were nestling among the fouling organisms on a buoy. The largest specimen had reached 11 mm. in length and was sufficiently well developed to be determined without question as *L. bisulcata* d'Orbigny.

Shell Structure

The structure of the shell of *Lithophaga* has been observed and discussed by Carpenter (1847) and List (1902). It is composed of three distinct layers. The outer non-calcareous, horny periostracum which is secreted by the mantle edge is subdivided into two layers: a thin outer, finely granulated portion which is generally brown or black in color and a thicker, lighter colored portion which is characterized by the presence of dorso-ventral lirations. The nacreous or mother of pearl layer is directly beneath the periostracum, a position unlike that of other mytilids and the majority of bivalves where this nacreous layer, if present at all, is innermost. The third and innermost layer of the shell is prismatic with each prism perpendicular to the nacreous layer, appearing polygonal in cross section, and surrounded by supporting conchiolin. Since the prismatic layer covers all the nacreous layer except for a small marginal area, the internal surface of *Lithophaga* normally appears dull and lustreless with iridescence showing only on the marginal or peripheral areas. Carpenter (1847) was the first to report the presence of peculiar tubules

which penetrate both the prismatic and nacreous layers; List (1902) corroborated this finding and elaborated further on their structure, presenting excellent evidence in microscopic sections of the shell. The tubules which are extremely small, as Carpenter noted, about 1/20,000 of an inch in diameter, appear to begin in the prismatic layer and extend

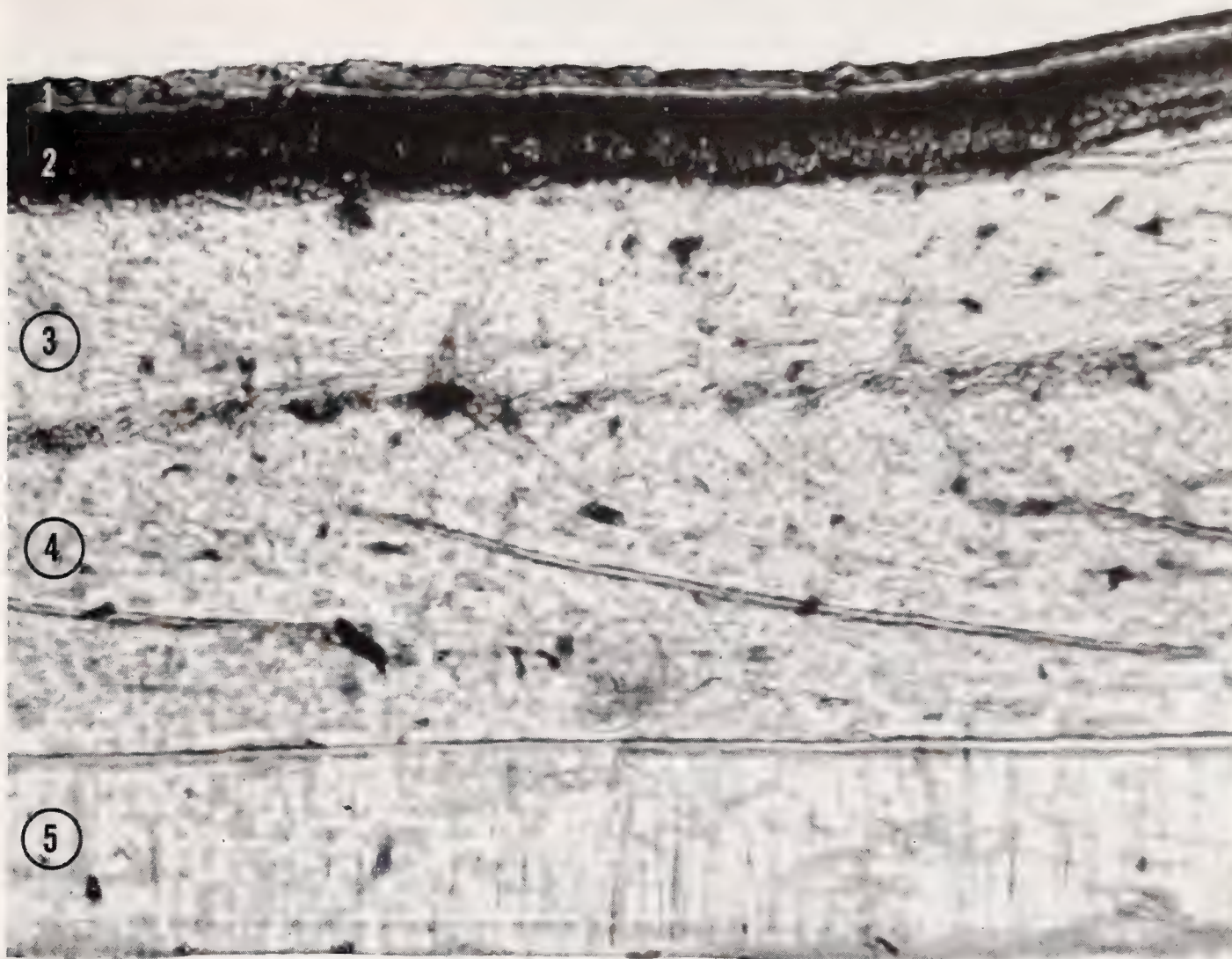


Plate 59. Cross section of the shell of *Lithophaga nigra* d'Orbigny from Soldier's Key, Florida. The various layers are indicated by numbers. 1. Outer layer of the periostracum. 2. Inner layer of the periostracum. 3. Outer layer of the laminated layer. 4. Inner layer of the laminated layer. 5. Prismatic layer. Section taken near the dorsal margin in the mid portion of the valve. (665 \times .)

into the nearby lamellae of the nacreous layer but not into the outermost lamellae. Unlike the tubules which have been found in *Anomia* and *Lima*, those of *Lithophaga* appear to be straight and parallel to one another; rarely do they anastomose or branch. Another peculiarity of the calcareous layers of the shell of *Lithophaga* has been cited by List (1902). He reported the presence of parasitic algae which occupy the special tubular spaces in both the prismatic and nacreous layers.

Plate 59 shows the position and relationship of the various layers of the shell of *Lithophaga nigra*. For the general external morphology of the shell, see the generic description of *Lithophaga* and Plate 63.

Notes on the Anatomy and Biology

The earliest work done on the anatomy of *Lithophaga* was that of Poli (1795) who described and figured the gross morphology of *Lithophaga lithophaga* Linné. Menegaux

(1890) described in some detail the circulatory system of the same species, and Pelseneer (1911) made some observations on the anatomy of *L. gracilis* Philippi from the Indo-Pacific. List (1902) did the anatomy and histology of the Mytilidae of the Mediterranean including *Lithophaga lithophaga* Linné. Working with living animals, Yonge (1955) described the ciliary tracts and the functioning of the mantle of *L. plumula* Hanley of the California coast, and Ridewood (1903) described the gill structure of *Lithodomus dactylus* Sowerby [= *Lithophaga lithophaga*].

The general morphology of the soft parts of *Lithophaga* is similar to that of *Mytilus*; the differences arise mainly from the transformations made necessary to accommodate the animal to a narrow and elongate shell, as well as those resulting from the use of the byssus and the byssal retractor muscles in boring. The most striking of these is the compact arrangement of the posterior adductor and posterior pedal-byssal retractor muscles and the reduction of the pedal retractors. In addition, the anterior adductor muscle is much larger in *Lithophaga* and is located ventrally.

The mantle in all species of *Lithophaga* examined is thin and transparent except at the margin where it is thickened and a mahogany-brown in color. Many of the organs can be identified through the thin mantle as shown in Plate 61, fig. 1, but the mantle becomes opaque in specimens preserved for a long period of time. The mantle is firmly attached to the shell along its thickened margin which is composed of three lobes. The thin outer lobe, which secretes the shell, is covered by the thick periostracum secreted by cells located between the outer and middle lobes. The middle lobe is evident only as a fine ridge following the edge of the valve. The inner muscular lobe forms a wide ventral fold or velum. Anteriorly the two halves of the inner lobe fuse and in *L. antillarum* this area is thickened and appears glandular. It can be extended out over the anterior surface of the valves where it functions in the boring process (see also under section on Boring). Posteriorly the inner lobe of the mantle produces the relatively short and mahogany-brown siphons. The dorsal or excurrent siphon is complete and has a simple margin which lacks papillae. The incurrent siphon is open ventrally. The margin is firmly attached to the surface of the animal at the base of the siphons and at the dorsal margin of the inner demibranch of the gills.

The arrangement of the major muscles is similar in all species of *Lithophaga* but in the size and shape of the muscles the species appear to be divided into two groups. Though we have seen preserved material of only limited series of five species it would appear that, in those species having a posterior prolongation on the shell, the anterior adductor mus-

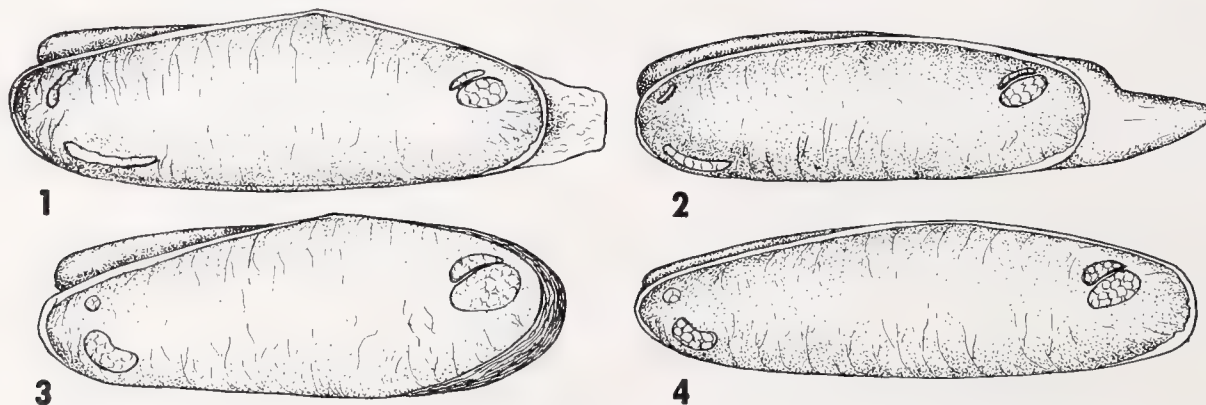


Plate 60. Figures of four species of *Lithophaga* with the left valve removed to show the surface of the mantle and the location of the muscles. Fig. 1. *L. bisulcata*. Fig. 2. *L. aristata*. Fig. 3. *L. nigra*. Fig. 4. *L. antillarum*. Note the resemblance between Figs. 1 and 2 and between Figs. 3 and 4. (About natural size.)

cle at the point of contact with the shell is long, thin and arcuate in cross-section while in those lacking the projection it is kidney-shaped. There appear also to be consistent differences in the shape of the pedal and byssal retractor muscles as shown in Plate 60. The small, digitiform, and extensible foot has rather weak retractor muscles and is apparently used only for the attachment of the byssal threads. The byssal gland is located posterior to the foot, and the threads, though few in number, are heavy and strong. The byssal retractor muscles are well developed and, with the attached byssus, function in moving the shell when boring (see section on Boring). The anterior byssal retractor divides just posterior to the stomach into right and left branches which attach to the valves just beneath the umbos. In Plate 61, fig. 2 the left half of this muscle has been deflected downward to show the large mouth, the funnel-shaped esophagus, and the labial palps. In Plate 61, fig. 1 the labial palps are in their normal position. The stomach is surrounded by the rather large, green digestive gland to which it is connected by means of several ducts so that it is difficult to remove the gland without breaking the walls of the stomach. The gastric shield is easily seen when the stomach is open, but the crystalline style, which lies in the mid-gut, just posterior to the stomach, quickly disintegrates and must be studied in well fed living specimens. Purchon (1957) has described in detail the internal structure of the stomach of *Lithophaga nasuta* Philippi from Singapore. The intestine which is imbedded in the gonads, extends posteriorly from the stomach almost to the posterior pedal-byssal retractor muscles where it turns dorsally, then anteriorly, passing beneath the pericardium and continuing forward nearly to the digestive gland. At this point it reverses, passes through the pericardium and the ventricle of the heart, then extends posteriorly over the dorsal surface of the posterior adductor muscle and opens in the normal position at the base of the excurrent siphon.

The open circulatory system is similar to that of other bivalves. The large ventricle of the heart occupies most of the pericardium while the two lateral, thin-walled auricles are located just ventral to it. There is a single aorta which opens from the anterior end of the ventricle and passes forward just beneath the thickened midline of the mantle. Just anterior to the heart a large trunk branches off which turns posteriorly and passes beneath the pericardium to supply the posterior portion of the animal. Continuing anteriorly the aorta again divides to send paired trunks into the viscera. A third pair of vessels branches off in the region of the esophagus and extends ventrally and then posteriorly along the anterior byssal retractor muscle to the foot. This third pair also sends branches into the labial palps, the anterior adductor muscle, the gonads, the foot, and the byssal retractor muscles. The pallial arteries run from the umbonal area ventrally and posteriorly along the margin of the mantle. These major vessels are illustrated by the dashed lines in Plate 61, fig. 2.

The main ganglia and trunks of the nervous system in freshly preserved specimens are a light salmon color and rather easy to observe. The circumesophageal nerve ring and the paired cerebral ganglia are connected by large commissures which extend posteriorly to the large visceral ganglion located on the anterior surface of the posterior adductor muscle. The paired pedal ganglia are located on the dorsal surface of the anterior byssal retractor muscle near the foot.

The reno-pericardial gland occupies the base of the pericardium and spreads over the surface of the auricles. It connects ventrally with the paired nephridia which are dark brown in color and which extend nearly the length of the animal. Waste products from

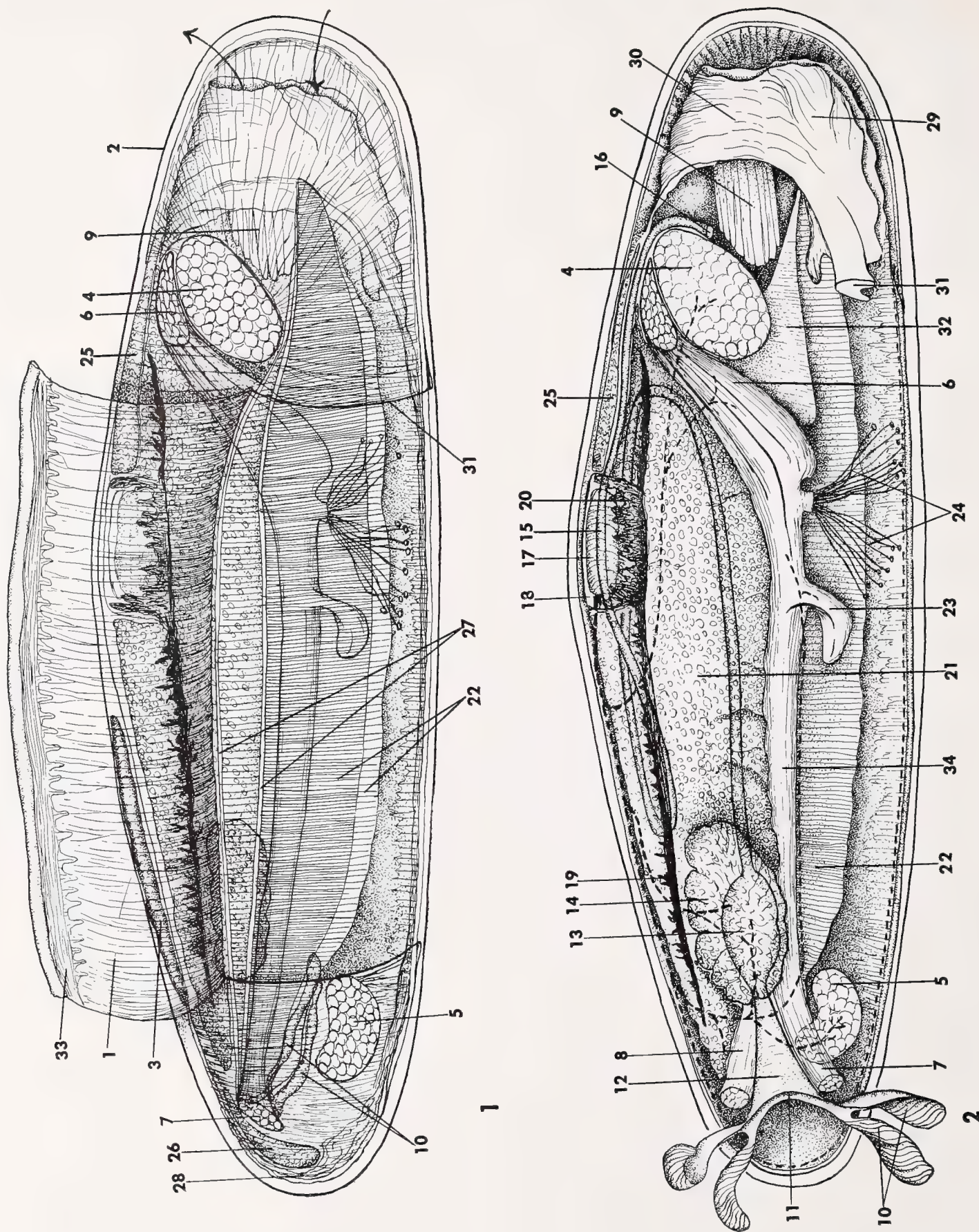


Plate 61

the nephridia and the reproductive products from the gonads empty into the supra-branchial chamber of the mantle cavity via separate orifices in a common uro-genital papilla-like projection. The gonads are large, extending nearly the length of the animal, and occupy most of the space dorsal to the pedal-byssal retractor muscles.

Though *Lithophaga lithophaga* has been well known in the Mediterranean area since very early times and was sufficiently common to be sold in the market, very little is known of its biology and life history. In fact, as far as we can determine nothing has been published on the life history of any species of *Lithophaga* other than the statement of MacGinitie (1935) that *Lithophaga plumula* Hanley spawned in January and February at Monterey Bay, California. He also stated that the larvae metamorphosed to the bivalve stage in ten days. Dr. G. Thorson, who has made a bibliography of marine invertebrate larvae, writes that he knows of nothing published on the breeding of *Lithophaga*. We have received from A. Merrill a lot of young *Lithophaga bisulcata* taken from St. Mary's buoy which is anchored 7 miles off the mouth of the St. Mary's River, Georgia. On the smaller specimens the embryonic valves were still visible and these are figured in Plate 62, figs. 1-2. On the anterior end of the valves, these young specimens have a fine pustule-like sculpture which is produced until the shells reach 4-6 mm. in length; this roughened surface may aid the animal during its initial settling into the crevices of a substrate. Figure 3 of Plate 62 illustrates changes in the outline of the shell during early growth. Since the depth of the water at the buoy is about five fathoms, it is evident that the veliger larvae of *L. bisulcata* are free swimming and come close to the surface. As previously mentioned, these specimens were not boring but nestling. Since the buoy was removed from its mooring for cleaning in November and since these specimens were very young, ranging in size from about 1.85 to 11 mm. in length, it would appear that at this locality *L. bisulcata* probably has a spawning period in the late summer or fall. The nestling of *Lithophaga* among fouling organisms on shipbottoms is a possible means of dispersal.

Copepod parasites are common in many bivalves and Ummerkutty (1960) reported the first species known to be parasitic on *Lithophaga*. He described it as a new genus and species of archinotodelphyid copepod, *Nearchinotodelphys indicus* Ummerkutty. The specimens were obtained from the mantle cavity of *Lithophaga straminea* Reeve [= *L. antillarum* d'Orb.] collected on the southeast coast of India.

Though Fischer (1886, p. 969), Allen (1950, p. 295), and others have reported simply that some date mussels are phosphorescent, this appears to need verification. *Lithophaga* is not mentioned by Mangold (1910) or Harvey (1957) in their comprehensive works on

Plate 61. Semidiagrammatic illustrations of the anatomy of *Lithophaga antillarum* d'Orbigny. Fig. 1. Specimen with the left valve removed and with the mantle cut just posterior to the anterior adductor muscle and just anterior to the posterior adductor muscle, and turned back to the line of attachment above the gills. Labial palps in their normal position. Fig. 2. Specimen with the mantle and gills removed. Labial palps turned to show position of the mouth.

1. Mantle. 2. Shell. 3. Ligament. 4. Posterior adductor muscle. 5. Anterior adductor muscle. 6. Posterior pedal-byssal retractor muscle. 7. Left anterior byssal retractor muscle. 8. Right anterior byssal retractor muscle. 9. Siphonal retractor muscle. 10. Labial palps. 11. Mouth. 12. Esophagus. 13. Stomach. 14. Digestive gland. 15. Intestine. 16. Anus. 17. Ventricle. 18. Pericardium. 19. Nephridium. 20. Renopericardial gland. 21. Gonads. 22. Ctenidium (gill). 23. Foot. 24. Byssus. 25. Posterior acid gland. 26. Anterior acid gland. 27. Branchial vessels. 28. Fused edge of mantle lobes. 29. Incurrent siphon. 30. Excurrent siphon. 31. Cut edge of mantle. 32. Branchial septum. 33. Pallial muscles. 34. Anterior pedal-byssal retractor muscle.

bioluminescence. It perhaps stems from Fougereux de Bondaroy (1768) who seems at times to have confused *Pholas dactylus* Linné and *Lithophaga lithophaga* Linné.

Though the Mytilidae are known to have existed as far back as the beginning of the Silurian (Schrock and Twenhofel, 1953, p. 394), the genus *Lithophaga* first appeared in the Pennsylvanian of North America. According to Shimer and Shrock (1944, p. 413), *Lithophaga carolinensis* Conrad is an index fossil of the Upper Cretaceous sediments of

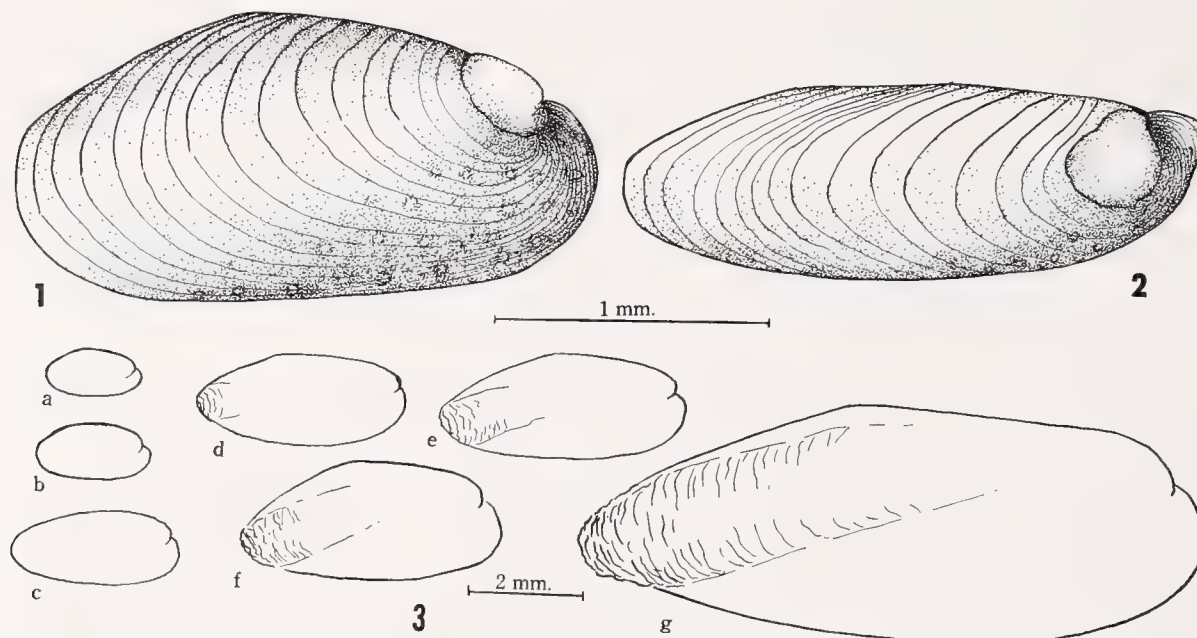


Plate 62. Figs. 1 and 2. Young specimens of *Lithophaga bisulcata* d'Orbigny showing the nepionic valves. Fig. 1. Lateral view of the right valve. Fig. 2. Dorsal view of same. Figs. 3a-g. Stages in the growth of young specimens showing the change in shape and the beginning of the development of the sulci and the calcareous incrustation. Specimens from St. Mary's Buoy off St. Mary's River, Georgia.

the Atlantic and Gulf Coastal plain. *Lithophaga claibornensis* Conrad is found in the Eocene. According to Dall, all four recent species of West Indian *Lithophaga* occur in the Oligocene Silex Beds of Ballast Point, Tampa Bay, Florida. In addition, Dall described as new *L. nuda* which is said to be very similar to *L. nigra*. Maury (1917) has recorded *L. nigra* and *L. antillarum* from the lower Miocene of Santo Domingo. Conrad (1866) described a *L. subalveata* from the lowest Miocene of Shiloh, New Jersey. This appears, however, to be a *Botula*. On the basis of the literature, *Lithophaga* appears to be rather common in the Tertiary of Europe and *Lithophaga lithophaga* Linné is known from the Miocene of Western Europe. According to Dall, because of the thin and fragile nature of the shell, most of the fossil specimens in North America are represented either by casts of burrows or by silicious pseudomorphs.

Notes on Classification

The family Mytilidae is a large and important family of filibranch, anisomyarian bivalves which are equivale but generally very inequilateral. The umbos are anterior or even terminal, the ligament is long and internal or nearly so, and the periostracum is heavy. The foot is small, digitiform, and there is usually a well developed byssus. The mantle lobes are joined only at the base of the excurrent siphon; the incurrent siphonal opening is continuous ventrally with the pedal opening.

Thiele (1935) groups the many species belonging in this family into eight genera while Soot-Ryen (1955) recognizes twenty seven. Undoubtedly the actual number lies some-

where between these two. Perhaps the most important genus is *Mytilus*, not only because it contains the largest number of species, but also because some members of this genus are important as items of food or as fouling organisms in nearly every maritime country in the world.

The genus *Lithophaga*, the most specialized of the mytilids, includes a relatively uniform group of species which are adapted for boring into calcareous rocks, coral, and shells. Thiele has considered *Botula* Mörch and *Adula* H. and A. Adams as subgenera of *Lithophaga*, but we agree with Soot-Ryen and others that these are distinct genera.

A total of at least 11 subgenera, including the nominate subgenus, has been proposed for the genus *Lithophaga* (the subgenus *Lithophaga* as understood by Thiele). We have seen type specimens of the type species of most of the described subgenera and we believe that there are far more subgenera than necessary for this small compact group. A monotypic subgenus has little meaning unless the species for which it is proposed is truly different. Therefore, we have attempted to group the species according to the basic characters given in the description of the genus, namely: 1) the sculpture, 2) the presence or absence of an incrustation, 3) the presence or absence of sulci dividing the valves, and 4) the type of the posterior prolongation if present. As a result, we have recognized four subgenera in the Western Atlantic and synonymized four. Of the remaining three subgeneric names, *Leiosolenus* Carpenter 1856 with the type species, *Lithophaga* (*Leiosolenus*) *spatiosa* Carpenter 1856 and *Myopalmula* Iredale 1939 with the type species *Litho-*

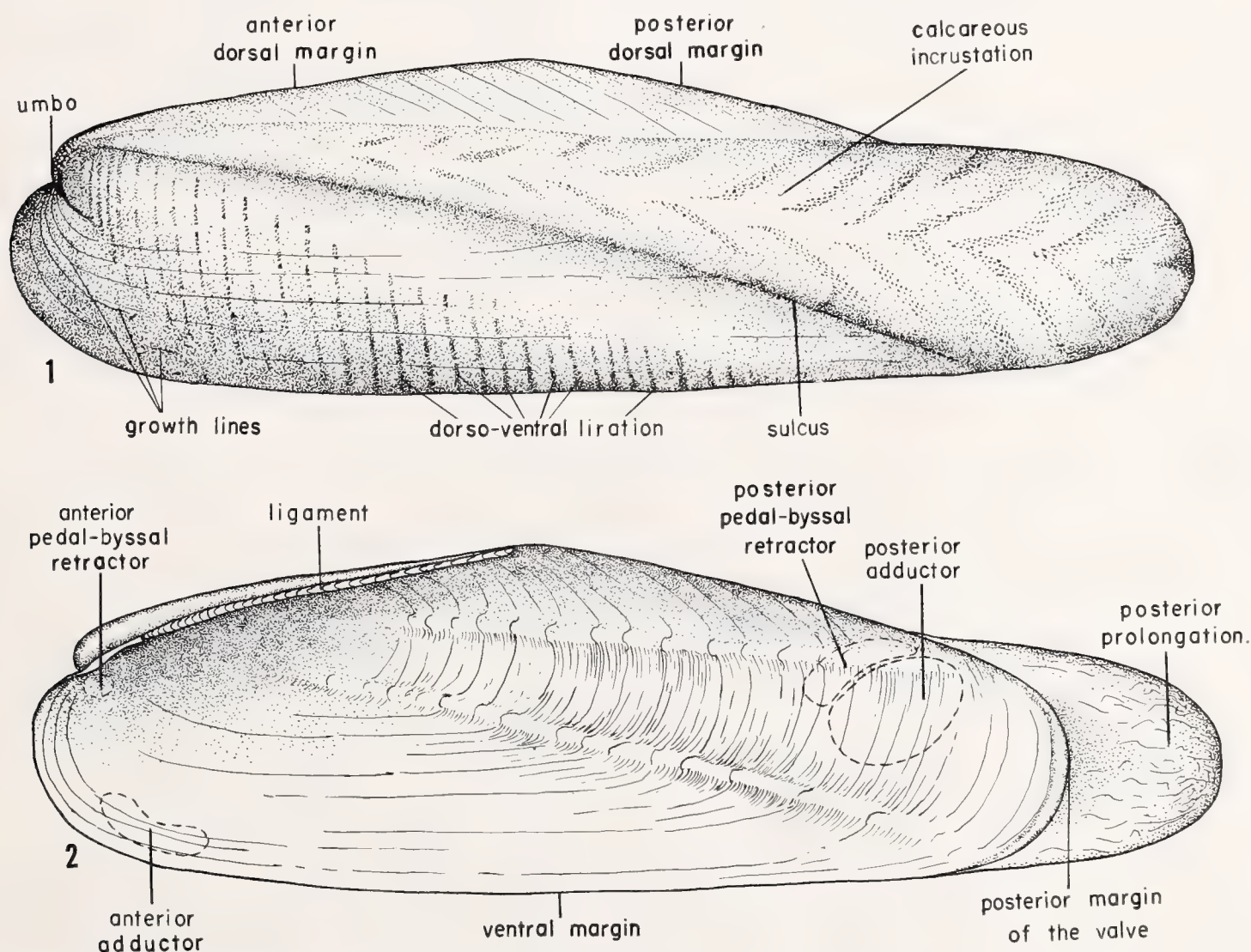


Plate 63. Composite diagrammatic illustrations of the parts of the shell. Fig. 1. External lateral view of left valve. Fig. 2. Internal lateral view of right valve.

phaga (*Myopalmula*) *dichroa* Iredale 1939 are both characterized by having a thin uniform incrustation covering the valve and by lacking any posterior prolongation beyond the valves; therefore, we consider these subgeneric names to be synonymous. Species belonging to *Leiosolenus* are found in the Eastern Pacific and the Indo-Pacific. It is possible that, when further material is available for study, only two subgenera will be recognized: one including those species having posterior prolongations on the shell and narrow arcuate anterior adductor muscle scars and the other including those species that lack the prolongations and have kidney-shaped anterior adductor muscle scars (see Plate 60).

ACKNOWLEDGMENTS

As with all numbers of *Johnsonia* many people have aided us in the work of this report. For the loan of material, we wish to thank H. A. Rehder, United States National Museum; R. T. Abbott, Academy of Natural Sciences of Philadelphia; F. Haas, Chicago Natural History Museum; E. B. Richardson, Charleston Museum; A. Clarke, National Museum of Canada; and D. F. McMichael, Australian Museum. We also wish to thank R. Robertson for sending freshly preserved specimens for dissection; J. Rosewater and V. Orr for photo copies of papers not available at the Museum of Comparative Zoology; J. Gaillard, of the Muséum National d'Histoire Naturelle, Paris, and N. Tebble, of the British Museum (Natural History), London for photographs of type specimens; J. Fitch of the California State Fisheries Laboratory for rock samples with *Lithophaga*; M. Billings and R. Siever of the Geology Dept., Harvard University for rock analyses; E. Barghoorn and J. Koob of the Harvard Herbarium for sectioning the shell and F. White for photographing. We also wish to thank W. J. Clench, M. Champion, R. W. Foster and A. Merrill for critically reading the manuscript.

Genus *Lithophaga* Röding

Lithophaga Röding 1798, Museum Boltenianum, p. 156.

Lithophagus Megerle von Mühlfeld 1811, Magazin der Gesellschaft Naturforschender Freunde, Berlin 5: 69 (type species, *Lithophagus communis* Megerle von Mühlfeld [= *M. lithophagus* Linné] monotypic; non Berthold 1827.

Lithodomus Cuvier 1817, Règne Animal 2: 471 (type species, *Mytilus lithophagus* Linné, monotypic).

Lithotornus 'Cuvier' Schweigger 1820, Handbuch der Naturgeschichte, Leipzig, p. 712 [error for *Lithodomus* Cuvier].

Lithodoma de Blainville 1823, Dictionnaire des Sciences Naturelles 27: 66 (type species, *Mytilus lithophagus* Linné, original designation).

Lithotomus Nitzsch 1825 [in] Ersch und Gruber, Allgemeine Encyclopädie 14: 175 [error for *Lithodomus* Cuvier].

Tamarindiformis Herrmannsen 1849, Indicis Generum Malacozoorum 2: 528.¹

Dactylus Mörch 1861, Malakozologische Blätter 7: 206 (type species, *Dactylus attenuatus* Deshayes, here selected); non Schumacher 1817.

Dactylus 'Lang' Jousseaume 1894, Le Naturaliste 16 (2): 201 (type species, *Dactylus tripartitus* Jousseaume, monotypic); non Schumacher 1817.

¹ Neave credited this genus to Herrmannsen, but in reality Herrmannsen was only listing the genus and credited it to Meuschen 1787, Museum Geversianum, p. 412, a work which should be placed on the Official Index of Rejected and Invalid Works in Zoological Nomenclature by the International Commission because all generic names, at least in the mollusca, are in the plural form.

Type species, *Lithophaga mytuloides* Röding [= *Mytilus lithophagus* Linné], monotypic.

Shell edentulous, elongate, subcylindrical, but generally becoming laterally compressed posteriorly. Umbos terminal or nearly so. Valves in some species divided by two radial sulci. Shell generally smooth with a heavy periostracum, and, in some species, with an incrustation of calcareous material which may be produced posteriorly beyond the valves. Color of the periostracum ranging from a light golden brown to nearly black. Ventral margin nearly straight; dorsal margin obtusely angled, the highest point of the shell being just posterior to the ligament. The ligament is long, narrow and internal. Anterior adductor muscle scar small and located near the anterior ventral margin. The anterior byssal retractor scar located just beneath the umbos. Posterior adductor and posterior pedal-byssal retractor scars large, adjacent, and located in the posterior quarter of the valve as shown in Plate 63.

Certain mytilid genera may be confused with the genus *Lithophaga* as it is presently defined. Thiele (1935) included within *Lithophaga* the subgenera *Adula* H. and A. Adams and *Botula* Mörch which have, since that time, been elevated to full generic rank by numerous workers. *Adula* may be distinguished from *Lithophaga* by its elongate, thickened, anterior dorsal margin and its short, obliquely truncated, posterior dorsal margin. Furthermore, in *Adula* the siphonal retractor muscle scars are well defined, the dorsal margin of the valves is sometimes crenulate, and the umbos are not terminal but are slightly removed from the anterior position. *Botula*, on the other hand, may be differentiated by the relatively shorter and higher proportions of the valves, the inflated umbos and the convex anterior and posterior dorsal margins which are thickened and crenulate. Unlike *Lithophaga* and *Adula*, the anterior byssal retractor muscles of *Botula* are inserted beneath or behind the inflated and incurved umbos. All three genera are members of the family Mytilidae and may be separated from the coral boring *Coralliophaga* de Blainville of the family Trapeziidae by the lack of cardinal and lateral hinge dentition.

The genus *Lithophaga* is world-wide in distribution mainly in tropical and subtropical waters but a few species extend into the temperate zone.

The genus has been divided into subgenera on the basis of shell ornamentation, as shown in the following key.

Key to the subgenera of the genus *Lithophaga*

1. Shell with calcareous incrustations 2
 Shell without calcareous incrustations *Lithophaga* s.s.
2. Valves divided by sulci *Diberus*
 Valves not divided by sulci 3
3. Shell with calcareous posterior prolongations crossed . . . *Myqforceps*
 Shell with calcareous posterior prolongations not crossed . . . *Labis*

* * * *

Key to the species of *Lithophaga* of the Western Atlantic

1. Shell with posterior prolongations 2
 Shell without posterior prolongations 3
2. Posterior prolongations of valves crossed *aristata*
 Posterior prolongations not crossed *patagonica*
3. Valves divided by two sulci *bisulcata*
 Valves not divided by sulci 4
4. Sculpture consisting of strong dorso-ventral lirations on the
 disc only *nigra*
 Sculpture consisting of weak dorso-ventral lirations on the
 disc, becoming chevroned on the posterior slope *antillarum*

Subgenus *Lithophaga* Röding

This subgenus is characterized by the lack of any calcareous incrustations or prolongations on the valves and by having a glabrous, medium to dark brown periostracum and fine dorso-ventral lirations on the disc.

Lithophaga (Lithophaga) lithophaga Linné

Plate 64, figs. 1–2

Mytilus lithophagus Linné 1758, Systema Naturae, ed. 10, p. 705 [in part, reference to Bonnani 1684, Recreatio, p. 102, fig. 28 and d'Argenville 1742, Hist. Nat., p. 365, pl. 30, fig. L].

Callitricoderma lithophagum Poli 1795, Testacea Utriusque Siciliae 2: 260.

Lithophaga mytuloides Röding 1798, Museum Boltenianum, p. 156 [refers to Gmelin 1791, *Mytilus lithophagus* Linné].

Lithophagus communis Megerle von Mühlfeld 1811, Magazin der Gesellschaft Naturforschender Freunde, Berlin 5: 69 [refers to Gmelin 1791, *Mytilus lithophagus* Linné].

Lithodomus lithophagus Linné. Cuvier 1817, Règne Animal 2: 471.

Modiola lithophaga Linné. Lamarck 1819, Histoire Naturelle des Animaux sans Vertèbres (1) 6: 115.

Lithodomus dactylus Sowerby 1824, The Genera of Recent and Fossil Shells, **Lithodomus**, no. 23, figs. 1–2 (no locality given).

Lithodomus inflatus Requien 1848, Catalogue des Coquilles de l'Ile de Corse, p. 30 (Ile de Corse).

Lithophaga lithoglypha 'Meuschen' Mörch 1853, Catalogus Conchyliorum Comes de Yoldi 2: 55 [error for *L. lithoglypha*].

Lithophaga lithoglypha 'Meuschen' Dunker 1882, Conchylien-Cabinet (2) 8 Abt. 3a, **Lithophaga**, p. 3, pl. 4, figs. 5–6 (Zara, Dalmatia).

Lithophagus lithophagus Linné. List 1902, Fauna und Flora des Golfes von Neapel. Monograph, no. 27, p. 11, pl. 3, figs. 1–9; pl. 4, figs. 19–22.

Lithophaga lithophaga Linné. Lamy 1937, Journal de Conchyliologie 81: 106.

Description. Shell elongate-elliptical in outline, reaching 91 mm. (about 3½ inches) in length and 27 mm. (about 1 inch) in height, thin and with anterior umbos. Umbos small but conspicuous and located very close to the anterior end of the shell, the anterior slope extending only slightly beyond the umbos. Color a medium golden brown to dark mahogany. Periostracum thin, smooth and shining. Sculpture consisting of low, irregularly spaced concentric ridges and growth lines. In addition, the area of the disc is sculptured with fine, more or less parallel but slightly wavy lirations which extend dorso-ventrally and cross the growth lines, giving a finely reticulate appearance. Interior of shell a bluish

gray and shining, often quite iridescent near the posterior end. Hinge line nearly straight, extending from the umbo to about midway on the dorsal margin. Muscle scars only slightly impressed, the anterior adductor scar kidney-shaped and located near the anterior ventral margin. The anterior byssal retractor scars nearly circular and located just beneath the umbos. Posterior adductor scar about midway between the end of the ligament and the posterior margin of the shell and confluent with those of the pedal and byssal retractors. Ligament internal, long and narrow.



Plate 64. *Lithophaga lithophaga* Linné. Fig. 1. External lateral view of left valve showing lirations on the disc. Fig. 2. Internal lateral view of right valve. Island of Malta, Mediterranean Sea. (Natural size.)

length	height	
91.0 mm.	24.0 mm.	Malta Island
90.0	26.5	“ “
90.0	26.0	Mahon, Minorca Id., Balearic Islands
84.0	24.5	“ “ “ “ “
67.5	24.5	Minorca Id.
18.0	6.0	Spezzia, Italy

Types. The holotype of *Mytilus lithophagus* Linné is in the collection of the Linnean Society of London. The type locality is here restricted to Ancona, Italy, the locality mentioned by D’Argenville 1743, p. 365, to which Linné referred. The type figure of *Lithophaga mytuloides* Röding is in the Conchylien-Cabinet (1) 8: pl. 82, figs. 729 and 730. The type of *Lithodomus dactylus* Sowerby is probably in the British Museum (Natural History). The locations of the type specimens of *Lithodomus inflatus* Requien and *Lithophaga lithoglypha* Dunker are unknown to us.

Remarks. A complete account of *L. lithophaga* is included in this report because it is the type species of the genus *Lithophaga*. Apparently it is a fairly common species though series in collections are not large. Johnston (1850) stated that in the Mediterranean the rocks were broken with large hammers in order to obtain them for food. They were considered a great delicacy throughout the Mediterranean countries and particularly in Italy where they were known as the ‘dattolo di pietra’ or ‘dattolo di mar.’ It was this species that bored into the columns of the so-called temple of Jupiter Serapis (see

also the Introduction). Bucquoy, Dautzenberg and Dollfus (1890, p. 163) record this species as fossil in the Miocene of Western Europe.

Lithophaga lithophaga is variable in both color and shape as attested by the measurements given above and reflected in the lengthy synonymy. It is perhaps most closely related to *L. nigra* of the Western Atlantic, from which it differs by having the anterior margin of the shell protruding slightly beyond the umbos. *Lithophaga nigra* is definitely darker in color, its posterior slope is higher, and the dorso-ventral lirations do not extend as far posteriorly on the disc. The thickening on the posterior end of *L. nigra* never occurs in *L. lithophaga*. In the latter species the posterior end of the shell is usually higher than the anterior end, whereas in *L. nigra* the dorsal and ventral margins are nearly parallel. Young specimens of these two species are difficult and often impossible to distinguish. See also Remarks under *L. nigra*.

Range. *Lithophaga lithophaga* occurs throughout the Mediterranean Sea and in the Red Sea near Tor, Sinai Peninsula, Egypt, according to Dunker (1882). According to Nickles (1950) it occurs on the west coast of Africa from Morocco to Sénégal. We have seen a lot from ballast taken at Cardiff, Wales in the collection of the United States National Museum. Such specimens may explain certain erroneous records.

Specimens examined. EUROPE. FRANCE: Nice (MCZ); Toulon (USNM). SPAIN: Cadiz; Malaga (both BMNH). ITALY: Spezzia (MCZ); Livorno (USNM); Viareggio (MCZ); Naples (MCZ; USNM). JUGOSLAVIA: Zara, Dalmatia (USNM). MEDITERRANEAN ISLANDS: Port Mahan, Minorca Id., Balearic Islands (MCZ; USNM); Malta Island (MCZ; USNM; BMNH). ASIA: Aden (BMNH).

***Lithophaga (Lithophaga) nigra* d'Orbigny**

Plate 65, figs. 1–5; Plate 66, figs. 1–3; Plate 75, figs. 2–3

Lithodomus niger d'Orbigny 1842 [in] Sagra, Hist. Nat. L'Ile de Cuba, Mollusques, Atlas, pl. 28, figs. 10–11; *ibid* 1853 Mollusques 2: 331 (Cuba).

Modiola (Lithophagus) antillarum Philippi 1847, Zeitschrift für Malakozoologie 4: 116; Philippi 1847, Abbildungen und Beschreibungen Conchylien 3: 20, pl. 2, fig. 4 (St. Thomas, Virgin Islands), *non* d'Orbigny 1842.

Modiola (Lithophagus) caribaea Philippi 1847, Zeitschrift für Malakozoologie 4: 116 (Antillae); 1847, Abbildungen und Beschreibungen Conchylien 3: 20, pl. 2, fig. 5.

Lithophaga nigra d'Orbigny. Mörch 1853, Catalogus Conchyliorum Comes de Yoldi 2: 56.

Lithodomus antillarum Philippi. Reeve 1857, Conchologia Iconica 10: **Lithodomus**, pl. 2, fig. 7, *non* d'Orbigny 1842.

Lithophaga crenulata Dunker 1848, Zeitschrift für Malakozoologie 5: 180 (Porto Cabello, Venezuela); Dunker 1883, Conchylien-Cabinet (2) 8 Abt. 3a, **Lithophaga**, p. 11, pl. 3, figs. 7–9.

Description. Shell elongate-elliptical in outline, reaching 65.5 mm. (about 2½ inches) in length and 20 mm. (about ¾ inch) in height, thin, fragile and with anterior umbos. Umbos small but conspicuous and located very close to the anterior end of the shell; anterior margin not extending beyond the umbos. Color a deep chestnut brown to nearly black. In many adult specimens the posterior margin of the shell is thickened and diverged, resulting in a labiate, or lip-like appearance as shown in Plate 65, figs. 3–4. Often at successive increments in the length of the shell a series of lip-like structures are formed which remain as pronounced ridges on the surface of the valves. Periostracum nearly

black, rather smooth and shining. Sculpture consisting of low, irregularly spaced, concentric growth lines and ridges. The area of the disc is sculptured with pronounced parallel lirations which extend dorso-ventrally and cross the growth lines, giving a reticulate appearance. Interior of the shell bluish gray, shining, with iridescence generally slight and limited to the area of the muscle scars. Hinge line nearly straight and extending from just posterior of the umbo to about midway along the dorsal margin. Ligament internal, narrowing anteriorly. Posteriorly the nacreous portion is smoothly rounded and the posterior area beyond this is somewhat angled and covered with periostracum. Muscle scars faintly impressed. Anterior adductor scar kidney-shaped and located near the anterior ventral margin; anterior byssal retractor scar nearly circular and located just beneath the umbos; posterior muscle scar, including the posterior adductor, the posterior pedal and byssal retractors is located just posterior to the arcuation of the posterior dorsal margin.

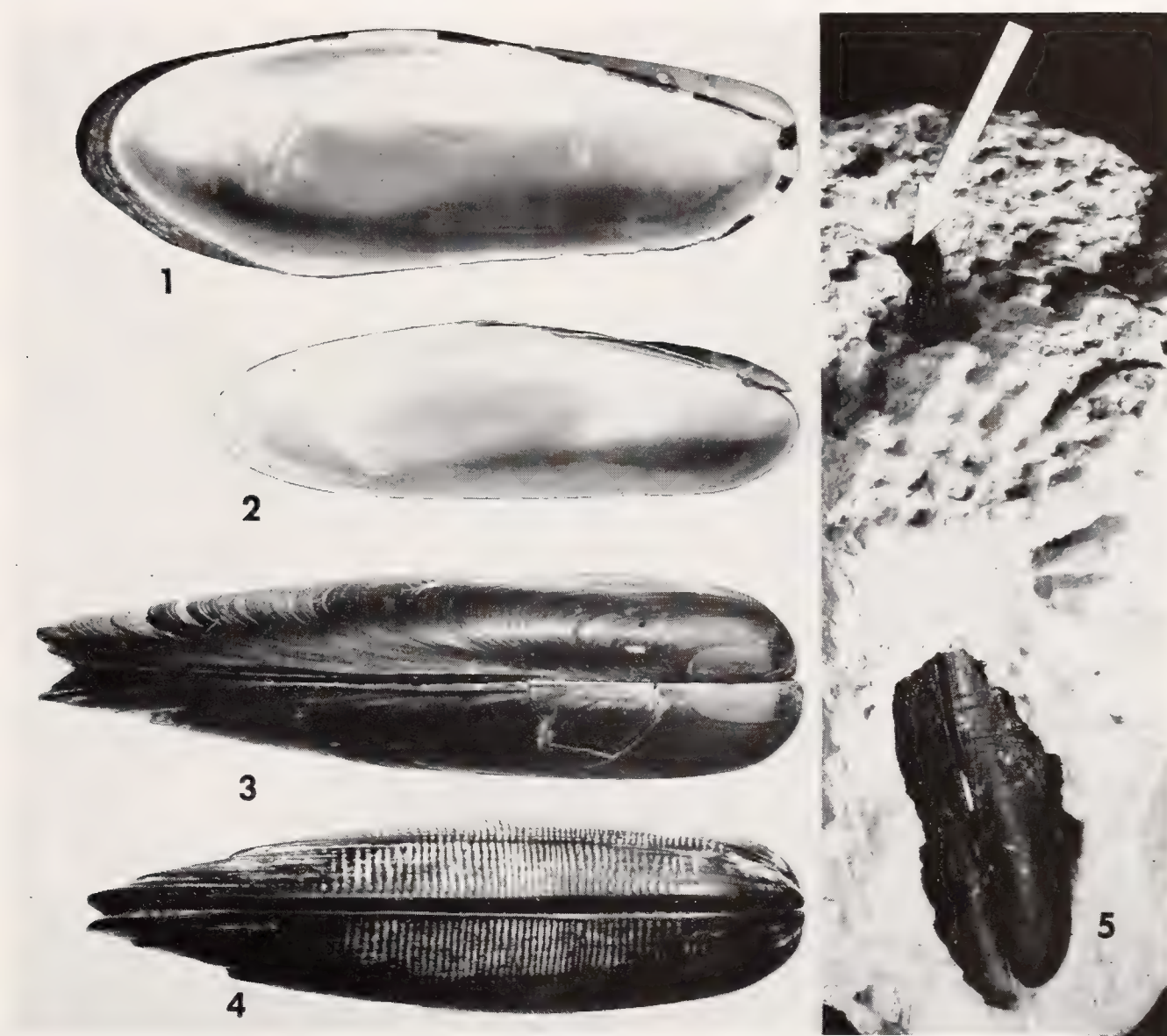


Plate 65. *Lithophaga nigra* d'Orbigny. Fig. 1. Internal view of the left valve showing the thickened posterior. St. John, Virgin Islands. Fig. 2. Internal view of the left valve of a young specimen from Cuba. Fig. 3. Dorsal view of opposed valves. Fig. 4. Ventral view of opposed valves. Figs. 3 and 4 from Bonefish Key, Florida. Fig. 5. Specimen imbedded in rock (arrow indicates the entrance of the burrow). Lower Florida Keys. (All $2\times$.)

length	height	
65.5 mm.	20.5 mm.	Bermuda
51.5	16.0	10 miles N of Hamilton, Bermuda
40.5	13.5	St. John, Virgin Islands
45.5	14.5	Bonefish Key, Florida
21.5	8.0	“ “ “

Types. The types of *Lithodomus niger* d'Orbigny are in the British Museum (Natural History) no. 54.10.4.604; the type locality Cuba, is here restricted to Guantánamo, Oriente, Cuba. The locations of the type specimens of *Modiola* (*Lithophagus*) *antillarum* Philippi from St. Thomas, Virgin Islands and *Modiola* (*Lithophagus*) *caribaea* Philippi from the Antilles are unknown to us. The type specimen of *Lithophaga crenulata* Dunker from Porto Cabello, Venezuela is probably in the Natural History Museum in Berlin, Germany.

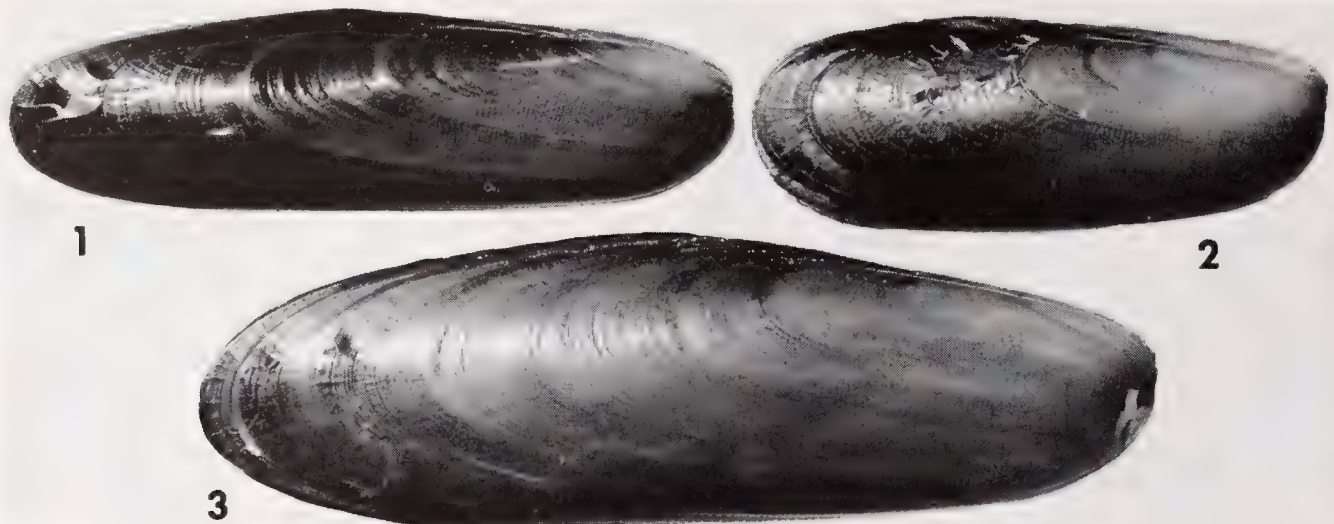


Plate 66. *Lithophaga nigra* d'Orbigny. A series showing variation in the shape of the shell. Fig. 1. A long thin specimen with an angled dorsal margin. Fig. 2. A short broad specimen with a nearly straight dorsal margin. Fig. 3. A typical specimen. All from Hamilton, Bermuda. (All about 2×.)

Remarks. This species is very close in its relationship to *Lithophaga lithophaga* Linné of the Eastern Atlantic and the Mediterranean, and in fact, in much of the early literature on the West Indies, it was referred to under this name. Such misidentifications have not been included in the synonymy. For further discussion on the relationship of these species see remarks under *Lithophaga lithophaga*. *Lithophaga nigra* is also closely related to *L. teres* Philippi 1846 of the Indo-Pacific; we have been unable to find any distinguishing characters to separate specimens of *nigra* and *teres* which are of equal size. However, since *L. teres* reaches a size more than twice that of the largest known specimens of *nigra*, we hesitate at this time to place it in the synonymy of *nigra*. As a matter of fact, the *L. lithophaga* of Europe, the *L. teres* of the Indo-Pacific region, and the *L. nigra* of the Western Atlantic form a complex whose precise interrelationships remain unknown due to a lack of ample material in research collections. It may well be that this complex represents a single cosmopolitan species with at least three subspecies. Furthermore, the three named species, *gracilis* Philippi 1847, *malayana* Philippi 1847, and *cylindrica* Krauss 1848, which are recorded from the Indo-Pacific region are probably *teres*, but more material is needed before this can be definitely stated.

Lithophaga nigra is a tropical and warm water subtropical species occurring in cal-

careous rock, corals and shells from the intertidal zone to depths of at least four fathoms. Specimens taken by the *Albatross* from 130 fathoms are based on shells only and it is doubtful that the species lives at that depth. Dall (1898) reports *L. nigra* as occurring in the Oligocene Silex beds of Ballast Point, Tampa Bay, Florida, a locality rather considerably north of its known distribution in Florida today.

For a discussion of the anatomy of this species see the Introduction.

Range. From Pompano, Florida south through the Florida Keys, Bermuda, the Bahama Islands and south through the West Indies to Trinidad; from British Honduras to Curaçao, Dutch West Indies and south to Abrolhos, Brasil. This species has been recorded by Dall (1898) and Johnson (1934) from South Carolina but this is open to question.

Specimens examined. FLORIDA: Pompano; Miami; Soldier's Key; off The Elbow, Key Largo; Carysfort Reef, off Key Largo; Bonefish Key; Ohio Key (all MCZ); Key West; Eastern Dry Rocks; Bird Key, Tortugas (all USNM); Fort Jefferson, Dry Tortugas (MCZ; USNM). BERMUDA: Castle Harbour; Harrington Sound; Hamilton; Pembroke (all MCZ); St. Georges (MCZ; USNM). BAHAMA ISLANDS: North Point, Elbow Cay and Turtle Cay, Abaco Island (both MCZ); New Providence (MCZ); Long Bay Cay District, Andros Island; Lisbon Point, Mangrove Cay, Andros (both USNM). CUBA: *Albatross*, station 2320, off Habana ($23^{\circ}10'39''$ N; $82^{\circ}18'48''$ W) in 130 fathoms; *Tomas Barrera*, station 231, off Cayo Levisa, in 2–3 fathoms and *Tomas Barrera*, station 218, off Cayo Hutia Reef, Pinar del Río (USNM); east of Farallone de Arena, Oriente (ANSP); Guantánamo, Oriente (MCZ). JAMAICA: Montego Bay (MCZ). HISPANIOLA: Santa Bárbara de Samaná, Santo Domingo (MCZ). VIRGIN ISLANDS: 1 mile south of settlement, Anegada (MCZ); Tortola (USNM; MCZ); St. John (MCZ); St. Thomas (MCZ; USNM; BMNH); Drift Bay, Water Island (USNM); St. Croix (MCZ). LESSER ANTILLES: Port Castries, St. Lucia; off Lord's Castle, Barbados in 3–4 fathoms (both USNM); Barbados (MCZ; USNM); Oistin Bay, Barbados in 4 fathoms (R. Gooding); Pelican Island, Barbados (USNM); Union Island, The Grenadines; Bucco Reef, Tobago; Carenage, Trinidad (all MCZ). BRITISH HONDURAS: Triangles ($17^{\circ}19'55''$ N; $88^{\circ}09'25''$ W) in 1–10 feet; Glory Cay ($17^{\circ}06'00''$ N; $88^{\circ}00'55''$ W) in 2–4 feet; north of Tarpum Cay ($16^{\circ}37'05''$ N; $88^{\circ}09'05''$ W) in 2–5 feet (all ANSP); coral reef near St. George's Cay, Belize (USNM). CARIBBEAN ISLANDS: Curaçao, Dutch West Indies (USNM). BRASIL: off Abrolhos in 30 fathoms [dead] (MCZ).

Lithophaga (Lithophaga) antillarum d'Orbigny

Plate 67, figs. 1–3; Plate 75, fig. 1

Lithodomus antillarum d'Orbigny 1842 [in] Sagra, Hist. Nat. l'Ile de Cuba, Atlas, pl. 28, figs. 12–13; *ibid.* 1853, Mollusques 2: 332 (Cuba; Guadeloupe; Martinique), *non* Philippi 1847.

Modiola corrugata Philippi 1846, Abbildungen und Beschreibungen Conchylien 2: 147, *Modiola*, pl. 1, fig. 1 (locality unknown).

Lithodomus stramineus 'Dunker' Reeve 1857, Conchologia Iconica 10, *Lithodomus*, pl. 2, fig. 11 (West Indies).

Lithophagus dactylus 'Sowerby' Mörch 1859, Catalogus Conchyliorum Comes de Yoldi 2: 55 [refers to *L. antillarum* d'Orbigny and *L. corrugata* Philippi], *non* Sowerby 1824.

Lithophaga straminea Dunker 1882, Conchylien-Cabinet (2) 8: abt. 3a, **Lithophaga**, p. 6, pl. 2, figs. 1-2 (*Antillae insulae*).

Lithophaga antillarum d'Orbigny. Dall 1898, Trans. Wagner Free Institute of Science, Philadelphia 3: 799.

Description. Shell lanceolate in outline, reaching 109 mm. (about $4\frac{3}{8}$ inches) in length with the anterior end being about one half the height of the posterior end. Broadly oval in cross section at the anterior end, becoming compressed laterally at the posterior end. Thin, fragile with inconspicuous anterior umbos, the anterior margin of the shell extending slightly beyond the umbos. Color a light straw-yellow to medium brown. Posterior margin simple and smoothly rounded. Periostracum thin and marked with exceedingly fine longitudinal lines when viewed under $30\times$ magnification. In adult specimens the

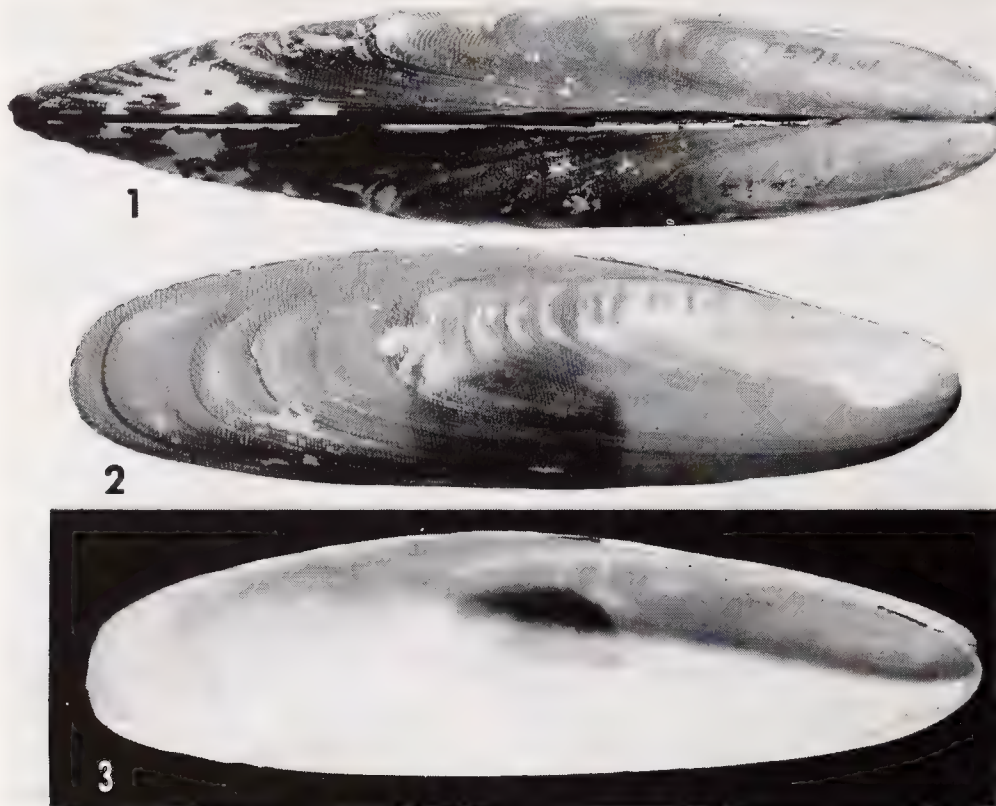


Plate 67. *Lithophaga antillarum* d'Orbigny. Fig. 1. Dorsal view of opposed valves. One mile S.W. of Soldier's Key, Florida. Fig. 2. External view of the right valve. Fig. 3. Internal view of the left valve (both from St. Thomas, Virgin Islands. (All natural size.)

periostracum is often worn away. Sculpture consisting of low, irregularly spaced, rather broad, concentric growth ridges. The area of the disc is sculptured with fine irregular lirae, which are more or less parallel anteriorly, becoming curved about midway and somewhat irregularly radiating or chevron-shaped at the posterior end. Interior of the shell grayish white to brownish purple, becoming whiter as the shell increases in age and thickness. Posterior half of the valves usually iridescent and the lirae are often evident. Muscle scars faintly impressed; anterior adductor scar kidney-shaped and located near the anterior ventral margin. Anterior byssal retractor scar located in the concavity of the umbos. Posterior muscle scar, including the posterior adductor, the byssal and pedal retractors, located about midway between the end of the ligament and the posterior end of the shell.

length	height	
109.5 mm.	25.0 mm.	Key West, Florida
101.0	26.5	Soldier's Key, Florida
83.5	23.5	Looe Key, Florida
44.0	12.5	Santa Bárbara de Samaná, Santo Domingo

Types. The types of *Lithodomus antillarum* d'Orbigny are in the British Museum (Natural History), no. 54.10.4.605. The type locality as given by d'Orbigny, which included Cuba, Guadeloupe and Martinique, is here restricted to Guantánamo, Oriente, Cuba. The location of the type specimens of *Modiola corrugata* Philippi and *Lithophagus dactylus* 'Sowerby' Mörch is unknown to us. The type of *Lithodomus stramineus* 'Dunker' Reeve is probably in the British Museum (Natural History); the type locality is the West Indies. The type of *Lithophaga straminea* Dunker is probably in the Natural History Museum in Berlin; the type locality is West Indies.

Remarks. This species, the largest of the lithophages found in the Western Atlantic, is readily distinguished by its light brown color, lanceolate shape, and lack of calcareous incrustations or posterior prolongations on the shell. In addition, it is differentiated by the chevron-shaped sculptural ridges on the posterior slope. The closest relative of *L. antillarum* in the Western Atlantic is *L. nigra* from which it may be distinguished by its light coloration and the sculpturing on the posterior end of the shell. *Lithophaga antillarum* is found boring into living or dead coral from the intertidal zone to depths of at least 6 fathoms. We have been unable to find a record of this species boring into shells but this is probably only a reflection of the fact that notes concerning the substrata into which the shells were boring are seldom added to the labels in collections.

The name *Lithophaga straminea* was first applied in manuscript to a shell in the Cumming collection by Dunker. It was labeled as from the West Indies. Reeve (1857) described and figured this specimen giving credit to Dunker with the type locality as the West Indies. Dunker (1882) later published a description and figures of the species and gave the locality as Antillae insulae. He compared his species to *L. corrugata* Philippi [= *antillarum* d'Orbigny] and suggested that more material might prove them to be the same. When Hedley (1906) first discovered what he called *L. straminea* Reeve, he recorded its occurrence as new to Australia. Later Lynge (1909) used *L. straminea*, considering it as an Indo-Pacific species, and stated that the locality "West Indies" given by Reeve was in error. Lamy (1937) followed Hedley and Lynge, and the name has attained wide usage in the Indian, Australian, and Japanese literature (i.e. Okada, 1960). Nevertheless, it is evident that the name *straminea* is not available since it is a synonym of *antillarum*. Furthermore, we are in agreement with Hedley and consider that only a single species with a discontinuous distribution is involved. We have not found any sufficiently distinguishing characteristics which will separate Western Atlantic specimens from Indo-Pacific specimens, and all series which we have seen from the Pacific fit well within the range of variation exhibited by the Atlantic specimens. When more material is available for study some consistent conchological or anatomical differences may be found, but at the moment this seems unlikely. Should the Indo-Pacific populations eventually prove to be a distinct subspecies or species, a new name will have to be proposed.

At the present time, it is difficult to explain the occurrence and distribution of this species in the Indo-Pacific, for it does not occur in the Eastern Atlantic or the Eastern

Pacific. It is possible that these two are relict areas remaining from a widespread Tethyan distribution. *Cymatium pileare* Linné has a similar distribution (see *Johnsonia*, 1957, no. 36, p. 216). It is also possible that *antillarum* was introduced into the Pacific during the early days of explorations in fouling on ships.

Range. WESTERN ATLANTIC: The known range of this species extends from Miami, Florida south through the West Indies and in Central America from Veracruz, Mexico south to British Honduras. INDO-PACIFIC: From Japan south to New Caledonia and Australia and west through the Gulf of Siam (Lyngé, 1909) to India (Ummerkutty, 1960).

Specimens examined. WESTERN ATLANTIC. FLORIDA: Miami Beach; Soldier's Key; 1 mile SW of Soldier's Key in 2 fathoms; Carysfort Light, in 2 fathoms; Western Dry Rocks (all MCZ); Bonefish Key (MCZ; USNM); Looe Key, off Marathon (MCZ); Key West, in 6 fathoms (MCZ; USNM). BAHAMA ISLANDS: Abaco Island (USNM). CUBA: Guantánamo, Oriente (MCZ; USNM). HISPANIOLA: Santa Bárbara de Samaná, Santo Domingo (MCZ). VIRGIN ISLANDS: Tortola (USNM); St. Thomas (MCZ; USNM; BMNH). MEXICO: Veracruz (MCZ); *Albatross*, station 2365, about 46 miles off Cabo Catoche (22°18' N; 87°04' W) in 24 fathoms (USNM). BRITISH HONDURAS: Glory Cay (17°06'00" N; 88°00'55" W) in 2–4 feet; N of Tarpum Cay (16°37'05" N; 88°19'05" W) in 2–5 feet (both ANSP). INDO-PACIFIC. JAPAN: Osima Osumi (MCZ). NEW CALEDONIA. AUSTRALIA. QUEENSLAND: Lindeman Id.; Cape York (all Australian Mus.).

Subgenus *Labis* Dall

Labis Dall 1916, Proc. United States National Museum 52: 405.

Type species, *Lithophaga attenuata* Deshayes, original designation.

Species in this subgenus are characterized by having a smooth shell with a very thin calcareous incrustation which becomes thicker posteriorly and extends beyond the valves as smooth projections, which may be rounded or triangular. The outer surface of these projections is convex and the inner surface may be flattened or slightly concave.

Lithophaga (*Labis*) *patagonica* d'Orbigny

Plate 68, figs. 1–4

Lithodomus patagonicus d'Orbigny 1847, Voyage dans l'Amérique Méridionale 5: 650, pl. 82, fig. 24; pl. 85, figs. 19–20 (l'Ensenada de Ros, sud du Rio Negro, Patagonie).

Lithodomus platensis Philippi 1893, Anales del Museo Nacional de Chile, Santiago, no. 10, p. 12, pl. 3, fig. 3 (late Miocene, La Bajada, Rio Parana, Corrientes, Argentina).

Lithodomus patagonicus dalli von Ihering 1907, Anales Museo Nacional, Buenos Aires 7(3): 275. (Golfo de San Jorge, Rada Tilly [6 miles south of Comodoro Rivadavia], formation Patagonienne moyenne [late Oligocene]).

Lithophaga (*Diberus*) *patagonica* d'Orbigny. Carcelles 1944, Revista del Museo de la Plata (n.s.) Sec. Zoología 3: 272, pl. 6, figs. 58–63.

Description. Shell elliptical in outline, reaching 41 mm. (about $1\frac{3}{4}$ inches) in length and 14 mm. (about $\frac{1}{2}$ inch) in height, thin, fragile, usually covered with irregular patches of gray-white calcareous material and with inconspicuous anterior umbos. Anterior

end of shell smoothly rounded. Periostracum moderately heavy and medium golden brown in color. Sculpture consisting of irregular concentric ridges and fine growth lines which are often partially to completely covered by the calcareous deposit. This deposit thickens towards the posterior end of the shell and generally extends beyond the posterior margin of the valves as a triangular prolongation, which is often broken, so that specimens appear truncated. The outer surface of the prolongation is convex and smooth except



Plate 68. *Lithophaga patagonica* d'Orbigny. Fig. 1. External view of the left valve. Fig. 2. Internal view of the right valve. Fig. 3. Ventral view of opposed valves. Fig. 4. Dorsal view of opposed valves showing the cup-shaped cavity between the posterior prolongations. From off Mar de la Plata, Argentina. (All about $2\times$.)

for fine growth lines; its inner surface has a slight concavity. Interior of the valves is a medium purplish brown, smooth and shining, often highly iridescent at the posterior margin. Anterior and posterior ends of the valves smoothly rounded, the anterior end being considerably higher and with a broader curvature. Ventral margin nearly straight, dorsal margin of two subequal portions, both the anterior and posterior portions of the dorsal margin slope at an angle of about 20° to a high point just posterior to the mid point of the dorsal margin. Ligament internal, strong, heavy, and extending from the umbos to the high point of the dorsal margin. Muscle scars lightly impressed, the posterior adductor with the adjacent posterior pedal and byssal retractor scars broadly oval and located about midway between the dorso-ventral margins in the posterior quarter of the shell. Anterior byssal retractor scar narrowly elliptical and located just beneath the umbos; the anterior adductor scar long, thin and arcuate, and located near the anterior ventral margin.

length	height	
41.0 mm.	14.0 mm.	Off Río de la Plata, Argentina
33.5	12.5	“ “ “ “ “ “
23.5	9.5	Mar del Plata, Argentina

Types. The holotype of *Lithodomus patagonicus* d'Orbigny is in the British Museum (Natural History) according to Gray (1854); the type locality is l'Ensenada de Ros, Río Negro, Argentina. The holotype of *Lithodomus platensis* Philippi is probably in the National Museum in Santiago, Chile; the type locality is the Tertiary Formation at La Bajada, Río Paraná, Corrientes, Argentina. The holotype of *Lithodomus patagonicus dalli* von Ihering is probably in the museum in São Paulo, Brasil. It is a Oligocene fossil from the Golfo de San Jorge, Argentina.

Remarks. *Lithophaga patagonica* appears to be a rather rare species to judge by the very few specimens found in museum collections. It is not closely related to any other species in the Western Atlantic. From *L. aristata*, the only other non-sulcate species in the Western Atlantic which has a posterior prolongation on the shell, *L. patagonica* differs by having the projection straight rather than crossed. It is most closely related to *Lithophaga attenuata* Deshayes from the Eastern Pacific from which it differs in being generally smaller and much less attenuate. In addition, the posterior dorsal margin of *patagonica* is straight while that of *attenuata* is concave.

Nothing is known of the life history of *Lithophaga patagonica* or the substrata into which it bores. Our records show that it occurs from the intertidal zone to depths of about 30 fathoms. The records would also indicate that this species prefers temperate waters rather than those of the tropics or subtropics as do most *Lithophaga*. It has been recorded by von Ihering under the subspecies name *dalli* from the Oligocene of Patagonia.

Range. So far as known, *Lithophaga patagonica* has a very restricted range. It occurs from Rio Grande do Sul, Brasil south, according to Carcelles and Williamson (1951, p. 328), as far as Comodoro Rivadavia, Golfo San Jorge, Argentina and in the Falkland [Malvinas] Islands.

Specimens examined. BRASIL: Sarita, Rio Grande do Sul (ANSP). URUGUAY: La Paloma, Roche (E. Duarte). ARGENTINA: Mar del Plata (USNM); *Albatross*, station 2765, about 18 miles NE of Punta Médanos, Buenos Aires (36°43' S; 56°23' W) in 10.5 fathoms (USNM); *Hassler* voyage, about 35 miles E of Querandi (37°40' S; 56°25' W) in 30 fathoms (MCZ; USNM).

Subgenus **Myoforceps** *Fischer*

Myoforceps Fischer 1886, Manuel de Conchyliologie, p. 969.

Type species, *Lithodomus caudigerus* Lamarck (= *Lithophaga aristata* Dillwyn), monotypic.

Species in this subgenus are characterized by having the smooth calcareous incrustation extending beyond the valves posteriorly and forming pointed projections which are crossed.

Lithophaga (Myoforceps) aristata Dillwyn

Plate 69, figs. 1–5; Plate 70, figs. 1–3; Plate 71, figs. 1–2; Plate 72, figs. 1–3

Mytilus curviroster Schröter 1787, Neue Litteratur 4: 268, pl. 3, fig. 12 (no locality given) [nomen oblitum¹].*Mytilus lithophagus striatus* Sowerby 1807, Trans. Linnean Soc. London 8: 274, pl. 6, fig. 2 (ballast stones, Tothill-fields, London, England) [nomen oblitum²].*Mytilus aristatus* 'Solander' Dillwyn 1817, Descriptive Catalogue of Recent Shells 1: 303 (Senegal).*Modiola caudigera* Lamarck 1819, Animaux sans Vertèbres 6: 116 (mers australes, les côtes d'Afrique).*Lithodomus caudigerus* Lamarck. Sowerby 1824, Genera of Recent and Fossil Shells, **Lithodomus** fig. 4 only.*Lithophagus caudatus* Gray 1827 [in] King, Narrative of a Survey of the Coast of Australia 2: 477 (refers to *Modiola caudigera* Lamarck 1819).*Mytilus ropan* Deshayes 1836 [in] Lamarck, Animaux sans Vertèbres (2) 7: 27 (l'Isle de Gorée du Cap Verd).*Modiola caudigera* Lamarck. Philippi 1846, Abbildungen und Beschreibungen Conchylien 2: 149, pl. 1, fig. 5.*Mytilus caudigera* Lamarck. Gibbs 1848, Catalogue of the Fauna of South Carolina, p. xxii.*Lithophagus aristatus gracilior* Carpenter 1856, Catalogue of the Reigen Collection of Mazatlan Mollusca, p. 129 (Mazatlan, Mexico).*Lithophagus aristatus tumidior* Carpenter 1856, Catalogue of the Reigen Collection of Mazatlan Mollusca, p. 129 (Mazatlan, Mexico).*Lithodomus forficatus* Ravenel 1861, Proc. Acad. Nat. Sciences Philadelphia, p. 44 (in coral from Blackfish Banks off Charleston bar, South Carolina).*Dactylus carpenteri* Mörch 1861, Malakozoologische Blätter 7: 206 (Puntarenas, Costa Rica).*Lithodomus bipenniferus* Guppy 1877, Proc. Sci. Association, Trinidad, p. 154; Guppy 1879, Journal of Conchology 2: 169 (Gulf of Trinidad).*Lithodomus (Myoforceps) caudigerus* Lamarck. Fischer 1886, Manuel de Conchyliologie, p. 969.*Lithophaga (Myoforceps) aristata* Dillwyn. Dall 1898, Trans. Wagner Free Institute of Science 3: pt. 4, p. 800.*Lithophaga arista* (Solander). Buchanan 1854, Journal of the West African Science Association 1: 40 [error for *aristata* 'Solander' Dillwyn].

Description. Shell reaching 52 mm. (about 2 inches) in length and 16.5 mm. (about $\frac{2}{3}$ inch) in height, thin, fragile, covered with a thin, gray-white, calcareous deposit and with anterior umbos. Anterior end of the shell smoothly rounded, the umbos only evident in very young specimens. Periostracum relatively thin and a golden brown in color. Sculpture consisting of concentric growth lines only and these are usually obliterated by the calcareous deposit. This deposit thickens toward the posterior end of the shell and extends beyond the posterior margin of the valves as more or less triangular prolongations which cross each other. The prolongation of either the right or left valve may be dorsal, both forms occurring in the same population (see under *Remarks*). Interior of the shell medium purplish brown, smooth, shining, and highly iridescent, particularly on the ventral posterior margin. Anterior and posterior ends of the valves smoothly and similarly rounded. Ventral margin straight, the dorsal margin angled and composed of two nearly equal portions. Both the anterior and posterior portions of the dorsal margin slope

¹To our knowledge, this name has never been used for this species though the description and figure are both good. This name has a priority of twenty-seven years, but we are compelled under Article 28, Section B of the International Code of Zoological Nomenclature (1961) to consider this a forgotten name (nomen oblitum) which is no longer available.

²There is considerable confusion concerning this name. In the text of the original description Sowerby definitely refers to some species in the subgenus *Lithophaga*, but the plate caption refers to a figure of *L. aristata*. In the plate caption there is confusion for it refers to figures 2 to 5 whereas on the plate the figures are numbered 1 to 4. The name may also be considered a nomen oblitum.

upward at an angle of about 20° to a central high point. The ligament extends from the umbo nearly to the high point on the dorsal margin. Muscle scars not impressed. The posterior muscle scar, including the posterior adductor, the byssal and pedal retractors broadly oval and located just posterior to the midpoint between the end of the ligament and the posterior margin of the valve. Anterior byssal retractor scar located in the concavity of the umbo. The anterior adductor scar long, thin, arcuate and located near the anterior ventral margin.



Plate 69. *Lithophaga aristata* Dillwyn. Fig. 1. Dorsal view of opposed valves. South Inlet, Lake Worth, Florida. Fig. 2. Ventral view of opposed valves. From off Sanibel Island, Florida. Figs. 3-5. Lateral views of shells to show variation in shape and in the direction of the crossing of the posterior prolongations. Fig. 3. From South Inlet, Lake Worth, Florida. Fig. 4. From Acapulco, Mexico. Fig. 5. From Faro, Algarve, Portugal. (All $2\times$).

length	height	
44 mm.	14 mm.	South Inlet, Lake Worth, Florida
37	12	" " " " "
28	11	" " " " "
25	10	Off Sanibel Island, Florida

Types. In his original description of *Mytilus aristata*, Dillwyn referred to Adanson 1757, pl. 19, fig. 20, and we here designate this to be the type figure. The specimen on which this figure was based is in the Adanson collection at the Museum National d'Histoire Naturelle, Paris. The type locality is Sénégal. According to Lamy (1937) the types of *Modiola caudigera* Lamarck are in the Museum National d'Histoire Naturelle, Paris and the locality given on Lamarck's label is Nouvelle-Hollande. Through the cooperation of J. Gaillard of the Laboratoire de Malacologie, we are able to figure Lamarck's specimens. The locality Nouvelle-Hollande [Australia] given on the label is apparently in error. The type specimens of *Lithophaga aristatus gracilior* and *L. a. tumidior* Carpenter are in the British Museum (Natural History). The type locality for both of these forms is Mazatlan, Mexico. The type of *Lithodomus forficatus* Ravenel is in the Charles-

ton Museum, Charleston, South Carolina. The type locality is Blackfish Banks, off Charleston, South Carolina in 14 fathoms. The type of *Dactylus carpenteri* Mörch from Puntarenas, Costa Rica is probably in the University Museum, Copenhagen, Denmark. The type of *Lithodomus bipenniferus* Guppy from the Gulf of Paria, Trinidad was lost in the fire that destroyed the Victoria Institute.



Plate 70. *Lithophaga aristata* Dillwyn. Fig. 1. External view of the right valve. Fig. 2. Internal view of the left valve showing the ligament. Both from off Sanibel Island, Florida. Fig. 3. Lateral view showing the crossed posterior prolongations. South Inlet, Lake Worth, Florida. (All $2\times$.)

Remarks. *Lithophaga aristata* is a common, easily recognized species not closely related to any other. It is the only species belonging to the subgenus *Myoforceps* and is one of the most widely distributed of all lithophages. It bores into a wide variety of shells including *Spondylus*, *Chama*, *Halotis*, *Patella*, *Strombus*, *Lambis*, and *Ostrea*, as well as calcareous rocks. We have seen a series which was taken from a large intake water pipe of a refining company in Amuay, Venezuela. A single specimen in the collection of the Academy of Natural Sciences of Philadelphia was labeled as having been taken from "the Barque Santee arriving in Boston after 3 years on the west coast of Africa." This was a young specimen and may have been taken from an oyster or other mollusk which was fouling the bottom of the ship or may possibly have been a nestler attached by its byssus threads in a small crevice among the fouling organisms. The wide range of *L. aristata* may well be the result of the variety of substrata into which it will bore. Certainly ships badly fouled with oysters are a perfect means of transport for these mollusks. Specimens in the United States National Museum from west Africa are in an *Ostrea*.

There is considerable variation in the size, shape and direction of crossing of the posterior prolongations of the valves of *L. aristata* and this is reflected in the rather lengthy synonymy given above. The prolongations may be broad, nearly equal in width and with only the tips crossed or they may be long, narrow and crossed near the posterior margin of the valves. In some populations nearly all specimens have the prolongation of the left

valve crossing dorsally, while in others that of the right valve is in the dorsal position and in still others the direction of crossing may be equally divided.

Though *L. aristata* is basically a littoral species, Soot-Ryen (1955) reports a living specimen taken from a depth of 165 fathoms.

Geologically, this species probably goes back to the Oligocene, as Dall (1898, p. 800) reports fragments from the Silex beds of Ballast Point, Tampa Bay, Florida, and Hertlein and Strong (1946) record it from the Pleistocene of the Galapagos Islands. See also *Remarks* under *L. patagonica* d'Orbigny.

Range. Though *Lithophaga aristata* has been reported from the Red Sea (Lamy 1937), Australia (Gray 1827) and Japan (Lischke 1871) these records need confirmation. We have not seen specimens nor have there been any recent reports of this species from these areas. The localities given by the above authors are all very general which adds doubt to the records. It is possible that these specimens could have come from ballast. To our knowledge this species has not been found living except in the tropical, subtropical and warm temperate areas of the Eastern Atlantic, the Western Atlantic, and the Eastern Pacific. In the Eastern Pacific it is distributed from the Gulf of California to Peru and in the Western Atlantic from North Carolina to Venezuela.

EASTERN ATLANTIC. PORTUGAL: Faro, Algarve (MCZ). MEDITERRANEAN ISLANDS: Malta (BMNH). CAPE VERDE ISLANDS: São Vincent (USNM). SENEGAL: Gorée (BMNH); Cap Vert, Dakar (MCZ; BMNH).

WESTERN ATLANTIC. NORTH CAROLINA: Shackleford Id.; 25 miles SE of Cape Fear (both USNM). SOUTH CAROLINA: Sullivans Id.; Blackfish Banks, off Charleston Bar, Charleston in 14 fathoms (both Charleston Mus.). FLORIDA: *Pelican*, station 167-5, 8 miles NE of Indian River Inlet, St. Lucie Co. in 16 fathoms (USNM); South Inlet, Lake Worth; Hillsboro Light, Pompano; American Shoal, off Cudjoe Key in 45 fathoms (all MCZ); *Eolis*, station 34, off Tortugas in 15 fathoms; Bird Key, Tortugas (both USNM); off Sanibel Island (MCZ); 3½ miles SW of Longboat Key, Manatee Co. in 6 fathoms (USNM); about 30 miles off Anclote Key, near Tarpon Springs (D. Moore); 15-20 miles ESE of Destin (MCZ). TEXAS: 107 miles SE of Galveston in 10 fathoms; Port Isabel (both MCZ). JAMAICA: Kingston Harbour (USNM). VIRGIN ISLANDS: St. Thomas (MCZ; USNM). LESSER ANTILLES: Grenada; Milford Bay, Tobago; Trinidad; Casper Grande Island, Trinidad (all MCZ). MEXICO: Veracruz; Contoy Island in 12-18 fathoms; Isla Mujeres, Yucatan (all MCZ). VENEZUELA: Amuay, Paraguaná Peninsula (ANSP); Cumaná; Gulf of Paria (both MCZ).

EASTERN PACIFIC: CALIFORNIA: La Jolla (ANSP); San Diego (USNM). MEXICO: Conception Bay (ANSP); Santa Margarita (USNM); San Luis Bonzaga (J. Fitch); ½ mile NE of La Paz; *Albatross*, station 2826, Gulf of California, E of La Paz (24°12' N; 109°55' W) in 9½ fathoms; and Cape San Lucas, all Baja California (all USNM); Punta Penasco, Sonora (MCZ; ANSP); Porto Libertad, Sonora (USNM); Mazatlan, Sinoloa (USNM); Manzanilla, Colima (ANSP); Acapulco, Guerrero (MCZ; ANSP; USNM). COSTA RICA: Bahia de Chatham, Isla del Coco (USNM). PANAMA: Perico Island; Balboa, Canal Zone (both USNM); Bay of Panama (MCZ). GALÁPAGOS ISLANDS: Tagus Cove, Albermarle Island (ANSP).

Subgenus *Diberus* Dall

Diberus Dall 1898, Trans. Wagner Free Institute of Science, Philadelphia 3: 799.

Doliolabis Iredale 1939, Great Barrier Reef Expedition 5: no. 6, Mollusca, pt. 1, p. 417 (type species, *Lithophaga laevigata instigans* Iredale, original designation).

Exodiberus Iredale 1939, Great Barrier Reef Expedition 5: no. 6, Mollusca, pt. 1, p. 417 (type species, *Lithophaga calcifer* Iredale, original designation).

Salebrolabis Iredale 1939, Great Barrier Reef Expedition 5: no. 6, Mollusca, pt. 1, p. 417 (type species, *Lithophaga divaricalx* Iredale, original designation).

Stumpiella Soot-Ryen 1955, Allan Hancock Pacific Expeditions 20: 93 (type species, *Lithophagus calyculatus* Carpenter, original designation).

Type species, *Lithophaga plumula* Hanley, original designation.

Species belonging to this subgenus are characterized by having the valves divided by two radial sulci extending from the umbos to the posterior margin of the valves. The wedge-shaped area between the sulci is heavily incrustated with a calcareous deposit. This incrustation may be nearly smooth, deeply pitted or sculptured with plumulose or diverging ridges. The extension of the incrustation beyond the valves varies in length, the outer surface is convex, the inner surface concave. In forms with short projections, a cup-shaped cavity may be formed when the valves are opposed.

A study of the paratypes of *Lithophaga calcifer* Iredale, *Lithophaga divaricalx* Iredale and *Lithophaga instigans* Iredale has indicated that these species, which are the type species of the subgenera of Iredale given in the synonymy above, fit well within the scope of the subgenus *Diberus*. The outstanding characteristic of the subgenus *Diberus* is the division of the valves by the radial sulci extending posteriorly from the umbos. At the time Dall described the subgenus, only *plumula* Hanley and *bisulcata* d'Orbigny were included. The former species generally has a very plumulose incrustation, but *bisulcata* varies from those which are plumulose to those which are slightly pitted or nearly smooth. Iredale's subgenera were based upon differences in the sculpturing of the incrustations which can be found within the range of variation of the sculpturing of *bisulcata* alone.

The subgenus *Stumpiella* Soot-Ryen has for its type species *Lithophaga calyculatus* Carpenter, a bisulcate species which by definition would place it in the subgenus *Diberus*;

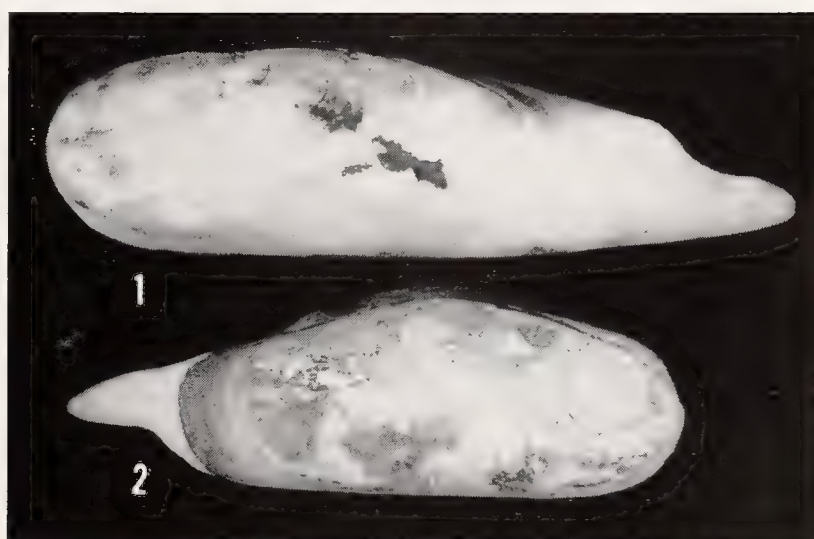


Plate 71. *Lithodomus forficatus* Ravenel [= *Lithophaga aristata* Dillwyn]. Fig. 1. External view of the left valve of the lectotype. Fig. 2. Internal view of the left valve of the paratype. From Blackfish Bank, off Charleston Bar, Charleston, South Carolina in 14 fathoms. (About 2×.)

the other characters mentioned by Soot-Ryen do not appear to be sufficient for the creation of another subgenus. It is probable that the subgenus *Rupiphaga* Olsson (1961) based on another bisulcate species *Lithophaga (Rupiphaga) hastasia* Olsson, also belongs with *Diberus*, but more material is needed for study before a definite decision can be made.



Plate 72. *Modiola caudigera* Lamarck [= *Lithophaga aristata* Dillwyn]. Specimens in the Muséum National d'Histoire Naturelle, Paris, considered by Lamy as the type specimens.

***Lithophaga (Diberus) bisulcata* d'Orbigny**

Plate 73, figs. 1-4; Plate 74, figs. 1-3; Plate 75, figs. 4-5

Lithodomus bisulcatus d'Orbigny 1842 [in] Sagra, Histoire Naturelle de l'Ile de Cuba, Mollusques 2: 333, pl. 28, figs. 14-16 (Cuba, Jamaica, Martinique, Santo Domingo and Guadeloupe).

Modiola appendiculata Philippi 1846, Abbildungen und Beschreibungen Conchylien 2: 150, *Modiola*, pl. 1, fig. 4 (Insula Cuba).

Lithophaga appendiculata Philippi. Mörch 1853, Catalogus Conchyliorum Comes de Yoldi 2: 56.

Lithodomus biexcavatus Reeve 1857, Conchologia Iconica 10, *Lithodomus*, pl. 4, figs. 22a-b (St. Thomas, West Indies).

Lithophaga (Diberus) bisulcata d'Orbigny. Dall 1898, Trans. Wagner Free Institute of Science, Philadelphia 3: 801.

Description. Shell elliptical in outline, reaching 41 mm. (about $1\frac{2}{3}$ inches) in length, the anterior end considerably higher than the posterior end, the dorsal margin with a slight alation, and the anterior margin extending slightly beyond the umbos. Valves thin, fragile and covered with a golden brown periostracum which is generally overlain by a gray-brown calcareous incrustation. Sculpture on the anterior slope and disc consists of rather regular and fine growth lines. The disc is sharply separated from the posterior slope by a rather deep sulcus extending from the umbo to the ventral margin near the posterior end of the valve. Posterior slope divided into two areas by a second sulcus which extends from the umbo to the dorsal margin of the posterior end of the shell. The wedge-shaped area between these two sulci has a heavy calcareous incrustation which is irregularly pitted. The pitting becomes more pronounced toward the posterior margin of the shell. The incrustation extends beyond the end of the valve, and its posterior mar-

gin is smoothly rounded. The area dorsal to the sulci is somewhat wedge-shaped or alate. Ventral margin of the valves slightly arcuate; the anterior and posterior margins rounded. The anterior dorsal margin is slightly concave and parallels the ventral margin; it is about $1\frac{1}{4}$ times the length of the posterior dorsal margin, which is slightly convex and descends rapidly to the narrow posterior margin. Interior of the shell a mottled grayish purple, usually somewhat iridescent at the posterior end. The sulci evident internally as low rounded ridges. Muscle scars slightly impressed, the anterior adductor scar long, thin and arcuate and located near the anterior ventral margin. The anterior byssal retractor scar small, irregularly elongate and located just beneath the umbos. The posterior muscle scar, including the posterior adductor and posterior pedal-byssal retractor scars, broadly elliptical and located on the dorsal ridge of the sulcus very close to the posterior end of the valve.

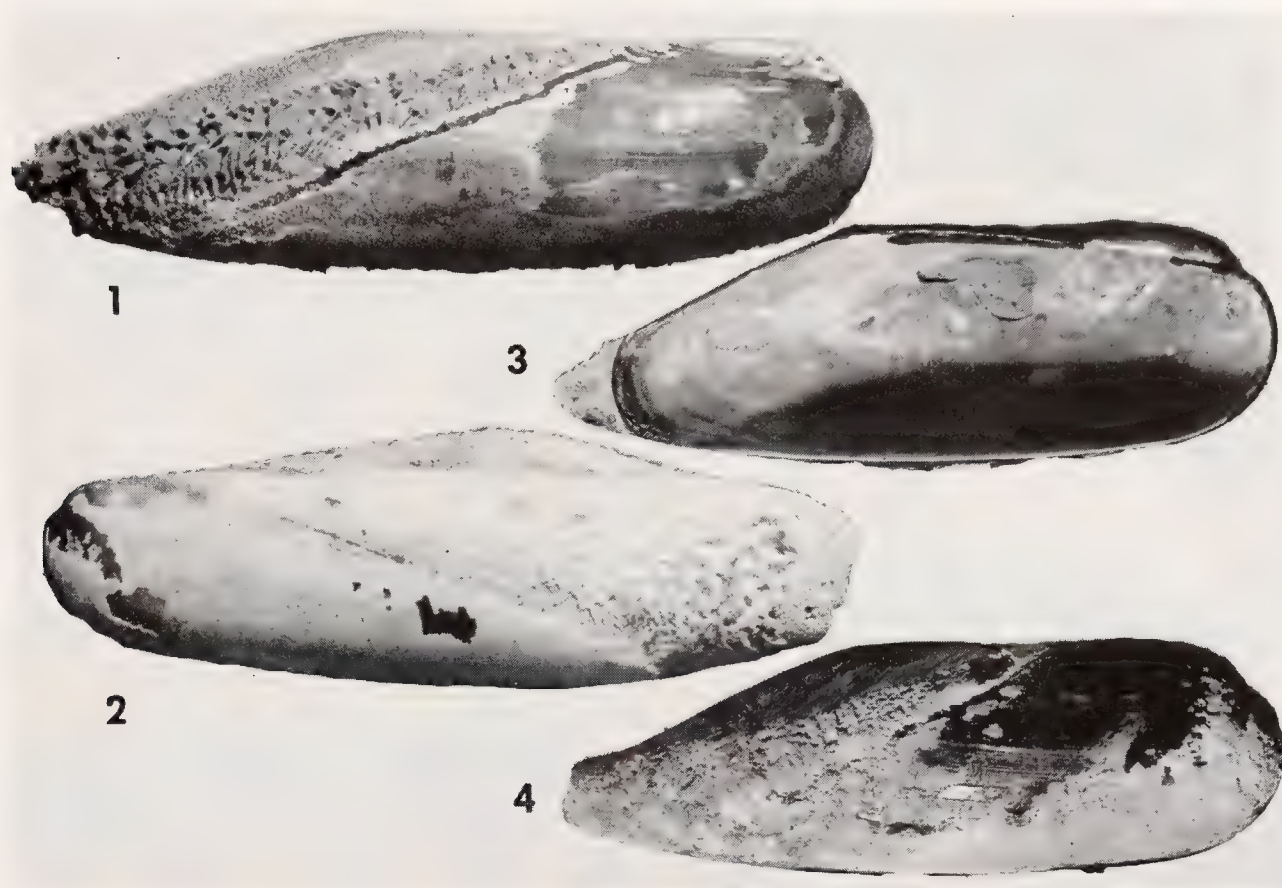


Plate 73. *Lithophaga bisulcata* d'Orbigny. Fig. 1. External view of the right valve. St. Augustine, Florida (about 2X). Fig. 2. External view of the left valve. From off Port Everglades, Florida (2.2X). Fig. 3. Internal view of the left valve. Fig. 4. External view of the right valve. Figs. 3 and 4 from Daytona Beach, Florida (both 2.1X).

length *	height	
34.5 mm.	12.0 mm.	Off Port Everglades, Florida in 7 to 9 fathoms
22.0	9.0	" " " " " "
42.0	14.0	" " " " " "
40.5	13.0	Bonefish Key, Florida
34.5	12.5	Beaufort, North Carolina
25.5	9.5	" " "
41.0	14.0	St. Thomas, Virgin Islands
36.0	13.0	Vitoria, Brasil
25.0	13.5	" "

* Not including the protruding calcareous incrustation.

Types. The types of *Lithodomus bisulcatus* d'Orbigny are in the British Museum (Natural History), no. 54.10.4.606. The type locality cannot be further restricted at this time because of insufficient records. The type of *Lithodomus biexcavatus* Reeve is also probably in the British Museum (Natural History); the type locality is St. Thomas, Virgin Islands. The location of the type specimen of *Modiola appendiculata* Philippi from Cuba is unknown to us.



Plate 74. *Lithophagus bisulcata* d'Orbigny. Fig. 1. External view of the left valve with nearly terminal umbos. Fig. 2. Internal view of the right valve showing the straight hinge line and the sulci as internal ridges. Fig. 3. External view of the right valve with the anterior margin extending beyond the umbos. All from Bonefish Key, Florida. (All $2\times$.)

Remarks. This is perhaps the most common species of *Lithophaga* in the Western Atlantic, and it is found boring into living coral. Krebs (1864) described the expanding wedge-shaped holes made in living coral as these lithophages moved outward in order to maintain contact with the surface. This species is also found boring into living shells such as *Strombus* as well as into dead coral and calcareous rock. When boring into coquina or other coarse-grained rocks they line their burrows with a fine, gray, amorphous calcareous deposit.

Lithophaga bisulcata is most closely related to *L. plumula* Hanley from the Eastern Pacific from which it differs in having the incrustation on the posterior slope far less elaborately sculptured. In general, *bisulcata* is a smaller species and has the posterior dorsal margin more nearly equal in length to the anterior dorsal margin, while in *plumula*, the posterior dorsal margin is much shorter than the anterior dorsal margin.

Lamy (1937) under the synonymy of *Lithophaga bisulcata* d'Orbigny lists the name "*Mytilus attenuatus* 'Gibbs' (non Deshayes), Cat. South Carol. pg. XXII." Gibbs

(1848) listed under the genus *Mytilus* the name *attenuata* Deshayes and simply referred to *Lithodomus* in Sowerby's Genera. On the single plate of *Lithodomus* in the Genera, figures 1 and 2 are labelled *dactylus*, and figures 3 and 4 *caudigera*, but figure 5 is unnamed. This may be the figure to which Gibbs was referring but as he did not quote figure numbers it is impossible to say. Therefore *attenuata* 'Deshayes' Gibbs need not be considered as it is a nomen nudum.

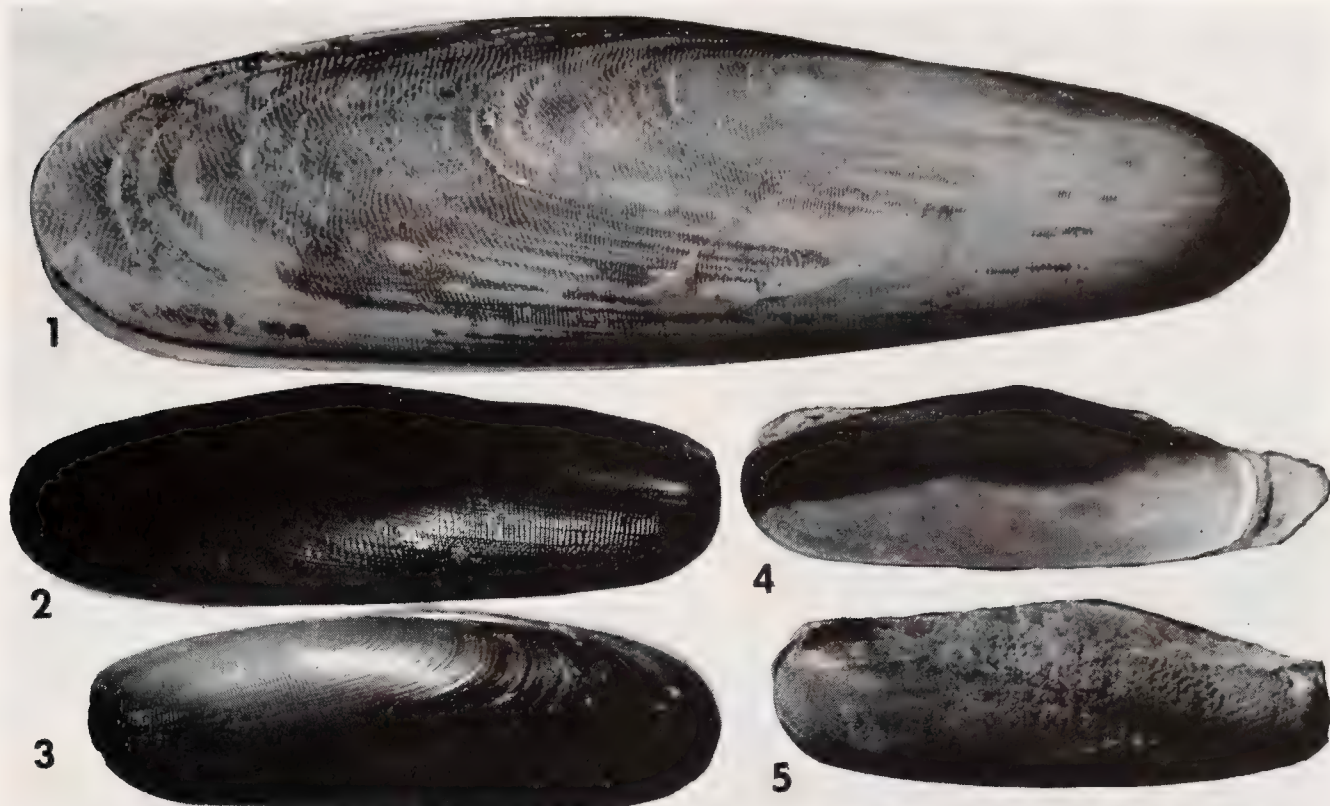


Plate 75. Fig. 1. *Lithodomus antillarum* d'Orbigny. Lectotype ($1\frac{1}{2}\times$). Figs. 2 and 3. *Lithodomus niger* d'Orbigny. Fig. 2. Lectotype. Fig. 3. Paratype ($1\frac{1}{2}\times$). Figs. 4 and 5. *Lithodomus bisulcatus* d'Orbigny. Lectotype ($2\times$). Photographs courtesy of the British Museum (Natural History).

Range. In the Western Atlantic this species extends from Beaufort, North Carolina south through the West Indies and the Gulf of Mexico to Vitoria, Brasil. In the Eastern Atlantic it is known from the island of St. Helena. It is found from the intertidal zone to depths of at least 79 fathoms.

Specimens examined. EASTERN ATLANTIC. St. Helena (USNM).

WESTERN ATLANTIC. NORTH CAROLINA: Beaufort; *Albatross*, station 2280, off Cape Hatteras ($35^{\circ}02' N$; $75^{\circ}21'30'' W$) in 16 fathoms (both USNM). SOUTH CAROLINA: 7 miles off Little River Inlet in $7\frac{1}{2}$ fathoms (USNM); NE of Pilot Boat, off Charleston in 8 fathoms; Pawleys Island (both Charleston Mus.). GEORGIA: from St. Mary's buoy, 7 miles off mouth of St. Marys River (A. Merrill). FLORIDA: St. Augustine (MCZ; USNM); Daytona Beach (MCZ); near Ozona; Lake Worth (both USNM); South Inlet, Lake Worth; Bonefish Key; off Port Everglades in 79 fathoms (all MCZ); *Albatross*, station 2370, about 30 miles SW of Cape San Blas ($29^{\circ}18'15'' N$; $85^{\circ}32' W$) in 25 fathoms (USNM); Sanibel Island (MCZ); $\frac{1}{2}$ mile N. of Whittaker Bayou, Sarasota Bay; $3\frac{3}{4}$ miles SW of Long Boat Pass, off Manatee Co. in 6 fathoms (both USNM); Madeira Beach, St. Petersburg (E. Marcott); Tampa Bay (MCZ; USNM); Apalachi-

cola; Pensacola (both USNM). LOUISIANA: West Rigolets Lighthouse (MCZ). TEXAS: *Atlantis*, station 107 miles SE of Galveston ($27^{\circ}54'05''$ N; $93^{\circ}35'02''$ W) in 10 fathoms; Port Aransas jetty; Cline's Point, Port Aransas; 50 miles off Port Arthur; Padre Island, Port Isabel (all MCZ). BERMUDA: Castle Roads, Castle Harbour, in 4–5 fathoms; $\frac{1}{2}$ mile S of North Rock, 10 miles N of Hamilton, in $1\frac{1}{2}$ fathoms (both MCZ); Harrington Sound (MCZ; USNM); between Trunk Island and south shore of Harrington Sound; Challenger Banks south of Bermuda (both MCZ). BAHAMA ISLANDS: Green Turtle Cay, Abaco Island in 15–25 fathoms (USNM); Clarence Town, Long Island (MCZ). CUBA: Cayo Levisa, Pinar del Río in 3 fathoms (USNM). HISPANIOLA: San Lorenzo Bay, Bahía de Samaná; Cayo Chico, $2\frac{1}{2}$ miles E of Santa Bárbara de Samaná, both Santo Domingo (both MCZ). JAMAICA: Kingston; Palisadoes (both USNM). PUERTO RICO: Port Real (USNM); San Juan (MCZ); Cabo Rojo (USNM). VIRGIN ISLANDS: St. Thomas (MCZ; USNM; BMNH); Mosquito Bay, St. Thomas in 2 fathoms; St. Croix (both USNM). LESSER ANTILLES: Falmouth, Antigua; Pelican Island; off Lord's Castle, Barbados; off Carlisle Bay, Barbados in 2–3 fathoms (all USNM); CARIBBEAN ISLANDS: Cayman Island (BMNH); Curaçao, Dutch West Indies (USNM). MEXICO: *Albatross*, station 2365, off Cabo Catoche, Yucatan ($22^{\circ}18'$ N; $87^{\circ}04'$ W) in 24 fathoms (USNM). BRITISH HONDURAS: Glory Cay ($17^{\circ}06'$ N; $80^{\circ}00'55''$ W) (ANSP). PANAMA: Colón (MCZ). COLOMBIA: Cartagena (USNM). VENEZUELA: Puerto Cabello (BMNH). BRASIL: Parahybat, Pernambuco (MCZ); Maceió (USNM); Rio de Janeiro (USNM); Vitoria (MCZ).

* * * *

REFERENCES

- Allan, Joyce 1950. Australian Shells. Georgian House, Melbourne. 459 pp., 44 pls., and 112 text figs.
- Amemiya, I.Y., and O. Amemiya 1923. Note on the habitat of rock-boring molluscs on the coast of central Japan. *Proc. Imperial Academy, Tokyo* **9**: 120–123.
- Berry, S.S. 1907. Molluscan fauna of Monterey Bay, California. *Nautilus* **21**: 17–21.
- Bohadsch, Joannes Baptista (Bohac, Jan Kritel) 1761. De quibusdam animalibus marinis. 169 pp., 12 pls. (German translation by N. G. Leske 1776. Beschreibung einiger minderbekannte Seethiere. (Dresden.) 160 pp., 12 pls.
- Bucquoy, E., Ph. Dautzenberg, and G. Dollfus 1887–98. Les Mollusques Marins du Roussillon, Paris **2**: Pelecypodes. 884 pp.
- Carazzi, D. 1903. Contributo all'istologia e alla fisiologia dei Lamellibranchi. *Internationale Monatsschrift für Anat. und Physiol.* **20**: 57–86.
- Carpenter, W.B. 1847. Report on the microscopic structure of shells. Part 2 in Report British Assoc. Advancement Science, pp. 93–134, pl. 120.
- Conrad, T. 1866. Illustrations of Miocene Fossils with Descriptions of new species. *American Journ. of Conchology* **2**: 73, pl. 4, fig. 4.

- Dall, W.H. 1898. Tertiary Fauna of Florida. Transactions of the Wagner Free Institute of Science of Philadelphia **3**: 571-916.
- Fischer, P. 1880-1887. Manuel de Conchyliologie. Paris. 1369 pp., 1158 text figs., 23 pls.
- Fougeroux de Bondaroy, A.D. 1768. Mémoire sur le coquillage appele datte en Provence. Mém. Math. et Phys. de L'Acad. Royal du Sci. Savans Etranger **5**: 467-478.
- Gibbes, L.R. 1848. Catalogue of the Fauna of South Carolina. Appendix to Tuomey 1848. Report on the Geology of South Carolina. 24 pp.
- Gray, J.E. 1847. A List of the genera of recent Mollusca, their synonyms and types. Proc. Zool. Soc. London, pp. 129-219.
- Gray, J.E. 1854. List of the Shells of Cuba in the Collection of the British Museum, collected by M. Ramon de la Sagra, described by Prof. Alcide d'Orbigny. London. 48 pp.
- Haas, F. 1942. The habits of life of some West Coast Bivalves. Nautilus **55**: 109-113.
- Harvey, E.N. 1957. A history of luminescence. Memoirs of the American Philosophical Society, Philadelphia **44**: 1-692.
- Hedley, C. 1906. Molluscs of Mast Head Reef. Proc. Linnean Soc. New South Wales **31**: 453-513.
- Hertlein, L.G., and A.M. Strong 1946. Mollusks from the West Coast of Mexico and Central America, III. Zoologica **31**: 53-76, pl. 1.
- Hodgkin, N.M. 1962. Limestone boring by the mytilid Lithophaga. Veliger **4**: 123-129, 3 pls. and 3 text figs.
- Imamura, A. 1926. On the recurrence of destructive earthquakes . . . Proc. Imperial Academy, Tokyo **2**: 264-267, 3 figs.
- Johnson, C.W. 1934. List of Marine Mollusca of the Atlantic Coast from Labrador to Texas. Proc. Boston Soc. Nat. Hist. **40**: 1-204.
- Johnston, G. 1850. An Introduction to Conchology. John van Voorst, London. 614 pp., 102 figs.
- Kuhnelt, W. 1930. Bohrmuschelstudien, I. Paleobiologica **3**: 51-91.
- Lamy, E. 1937. Révision des Mytilidae vivants du Museum National d'Histoire Naturelle de Paris. Journ. de Conchyliologie **81**: 99-132; 169-185.
- Lischke, C.E. 1871. Japanische Meeres-Conchylien. Novitates Conchologiae Supplement 4, pt. 2, Vol. 2, p. 149.
- List, T. 1902. Die Mytiliden des Golfes von Neapel. Fauna und Flora Golfes von Neapel, Monogr. 27. 312 pp., 22 pls. Berlin.
- Longwell, C.R. 1951. The so-called 'Temple of Jupiter Serapis.' American Journ. Science **249**: 929-931.
- Lyell, C. 1877. Principles of Geology. 12th ed., Appleton & Co., New York. 2 vols.
- Lynge, H. 1909. Danish Expedition to Siam 1899-1900 IV. Marine Lamellibranchiata. D. Kag. Danske Videnskabernes Selskab Skrifter (7) Naturvidensk og mathem, Kobenhavn, **5**(3): 100-299, pls. 1-5.
- MacGinitie, G.E. 1935. Ecological Aspects of a California Marine Estuary. American Midland Naturalist **16**: 629-765, 20 figs.
- Mangold, E. 1910. Die Produktion von Licht. Hand. Vegl. Physiol., Jena **2**: 225-392.
- Maury, C.J. 1917. Santo Domingo Type Selection and Fossils. Pt. 1. Bull. American Paleontology, Ithaca, N.Y., **5**(29): 223-388.
- Ménégaux, A. 1890. Recherches sur la circulation des Lamellibranches marins. Besançon. 291 pp.
- Okada, Y.K. 1960. Encyclopaedia Zoologica, Hokuryuhan Co. Ltd., Tokyo **3**: 200 pp., 91 pls.
- Olsson, A. 1961. Mollusks of Tropical Eastern Pacific. Panamic Pacific Pelecypoda. Paleontological Research Inst., Ithaca, N.Y., 574 pp., 86 pls.

- Osler, E. 1826. On burrowing and boring marine animals. Philosophical Transactions of Roy. Soc. London **116**(3): 342-371, 2 pls.
- Pelseneer, P. 1911. Les lamellibranches de L' expedition du Siboga. Siboga-Expeditie, Leiden, Monogr. **53a**, 125 pp.
- Poli, I.X. 1795. Testacea Utriusque Siciliae **2**: 215-221, pl. 32.
- Purchon, R.D. 1957. The stomach in the Filibranchia and Pseudolamellibranchia. Proc. Zool. Soc. London **129**: 27-60, figs. 1-13.
- Ridewood, W.G. 1903. On the structure of the gills of the Lamellibranchia. Philosophical Transactions Roy. Soc. London, Series B, **195**: 147-284.
- Shimer, H.W., and R.R. Shrock 1944. Index fossils of North America. John Wiley and Sons, New York. 837 pp., 301 pls.
- Shrock, R.R., and W.H. Twenhofel 1953. Principles of Invertebrate Paleontology. McGraw-Hill, New York. 816 pp., numerous figures.
- Soot-Ryen, T. 1955. A report on the family Mytilidae (Pelecypoda). Allan Hancock Pacific Expeditions **20**: 1-154, 10 pls.
- Spallanzani, L. 1809. Travels in Two Sicilies. (English translation by J. Pinkerton. Vol. 5, p. 33.)
- Thiele, J. 1935. Handbuch der systematischen Weichtierkunde. Gustav Fischer, Jena **2**: 779-1154.
- Ummerkutty, A.N.P. 1960. Studies on Indian Copepods 3. Journ. Marine Biol. Assoc. India **2**: 165-179.
- Yonge, C.M. 1955. Adaptations to rock boring in Botula and Lithophaga (Lamellibranchia, Mytilidae) with a discussion on the evolution of this habit. Quart. Journ. Micro. Sci. **96**: 383-410.

* * * *

BOOK REVIEW

British Prosobranch Molluscs, their functional anatomy and ecology, by Vera Fretter and Alastair Graham, 1962, Ray Society Publication no. 144. Printed for the Ray Society by Allard & Son Ltd. and sold by Bernard Quaritch Ltd., 11 Grafton Street, London W1, England. 775 pages, 317 figures. Price £ 8, 8s (\$23.52).

This is one of the finest books ever published on the anatomy of mollusks and particularly one covering such a large field. Most of the illustrations were made by the authors especially for this book. They are beautifully executed and clearly labeled so that when used in conjunction with the text one can readily dissect an animal and trace all points discussed. Chapter 1, on the anatomy of *Littorina littorea*, would make an excellent laboratory manual for an Invertebrate Zoology course, for all terms are defined and discussed as the dissection progresses. In succeeding chapters all the major systems are discussed in detail, showing their development through the prosobranchs. Chapter headings such as Feeding, Spawn, Development, Larval Forms and Parasites of Prosobranchs indicate the breadth of the book. The section on Ecology includes six chapters, and here, as throughout the book, there is much new information resulting from the lifetime researches of the authors. There is an excellent bibliography and three complete indices—author, subject and systematic—allowing one to locate desired information readily.

—R. D. TURNER

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Published by
THE DEPARTMENT OF MOLLUSKS
Museum of Comparative Zoölogy, Harvard University
Cambridge, Massachusetts

FEBRUARY 13, 1964

ELLOBIIDAE

VOL. 4, NO. 42

THE GENERA *PEDIPES* AND *LAEMODONTA* IN THE WESTERN ATLANTIC

BY
WILLIAM J. CLENCH

In this study we have included the two species of *Pedipes* known from both coasts of the Americas, one in the Western Atlantic and one in the Eastern Pacific.¹

Members of the genus *Pedipes*, similar to most other genera in the Ellobiidae, are subject to considerable variation. Much of this is brought about by the variation in their ecology, which unquestionably must play an important part in the general structural characters of their shells.

They usually occur near the upper tide level, generally in brackish water, in areas subject to marked changes, not only seasonally but even during a single day.

The two species are colonial, very similar to the condition prevailing among the marine species in the Truncatellidae. A colony becomes established, flourishes for a time, then may disappear when factors in the environment become impossible for its survival. They seem to prefer a hard substrate such as rocks or oyster shells, situations where there are crevices or other irregularities in which to crawl.



Plate 76. *Pedipes mirabilis* v. Mühlfeldt. Fig. 1. Cabo Rojo lighthouse, Puerto Rico (11.5x). Fig. 2. Lectotype of *Pedipes ovalis* C. B. Adams (= *mirabilis* v. Mühl.) MCZ, no. 177349. Fig. 3. Lectotype of *Pedipes globulosus* C. B. Adams (= *mirabilis* v. Mühl.), Jamaica (12.5x) MCZ, no. 177347.

¹ A second West Coast species "*Pedipes*" *unisulcata* Cooper from California, previously considered a *Pedipes*, is in the genus *Marinula* King and Broderip.

Férussac adopted the name from Adanson, the latter a pre-Linnean author who had given the name *Pedipes* to these little creatures because of a loping method of progression, an attempt to latinize the French word "pieten," a pedestrian.

Several synonyms are based upon young stages. The young, besides being much smaller, are structurally quite different from the adults. The shells are very thin, even translucent, and possess only the developing parietal plicae. In the adult stage, the shell is materially thicker, the parietal plicae much stronger, and in addition, a well developed palatal tooth is formed between the mid-region and the upper attachment of the outer lip. This variation was also indicated by Pfeiffer in using the names of *tridens* and *quadridens*, both synonyms of *P. mirabilis* v. Mühlfeldt.

Generally a colony consists of individuals of similar size; that is, all are the same age. This indicates a common origin, perhaps from a single individual or at least only a few individuals of the same age derived from a single source. This would naturally influence the describer who had such a series of specimens available for study. The assumption would be, owing to the uniformity of the individuals, that he was dealing with a "species" rather than a growth stage in the development of a species.

Variation is also exhibited in the size of the adult, with many examples in a single lot from one locality appearing to be fully adult and having all of the aperture dentition of other specimens two and three times their size. These mixed colonies may well represent two or more introductions from different populations. A new colony may become established by flotsam upon which egg masses or young from more than one population manage to arrive in one place.

Though the genus is world-wide in distribution in the tropics and south temperate zone, occurring on both sides of the Atlantic, the Eastern Pacific and the Indo-Pacific, species are few and colonies never abundant. Specimens may be abundant at any one place but to judge by the limited series we have had available, colonies are infrequently encountered. There is nothing in the literature, so far as we can trace, concerning their life history.

The family Ellobiidae is exceedingly complex, not only on a generic level but particularly in regard to the various species. These are to be found along the shores of most temperate and tropical seas. Generally the species are found in salt marsh and mangrove areas where brackish water conditions exist. A few occupy stations along open beaches in beach rubble or under stones and dead coral. The genus *Pythia* of the tropical portions of the Western Pacific is terrestrial, living in the woods and brush from the upper strand line and margins of mangrove swamps to many miles inland.

The genus *Carychium*, widespread in North America, Europe and Asia, is terrestrial. The various species are all small and are usually found under logs and stones in damp situations.

For a comprehensive report on the evolution and the morphology of several genera in the Ellobiidae, see J. E. Morton (1954). K. O. Meyer (1955) gives a very detailed report on *Ovatella myosotis* (Drap.).

The genus *Pedipes* is closely related to *Laemodonta* Philippi and *Marinula* King and Broderip.

The following will help in separating these complex genera.

Pedipes	Laemodonta	Marinula
rounded-ovate	ovate-conic	ovate-oblong
sculptured	sculptured	smooth or faintly spirally lyrate
imperforate	usually umbilicate	imperforate
3 plicae on inner lip	3 plicae on inner lip	3 plicae on inner lip
1 tooth on outer lip	1 to 3 teeth on outer lip	outer lip without teeth

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ACKNOWLEDGMENTS

I am greatly indebted to C. G. Aguayo, L. G. Hertlein, H. A. Rehder, D. and N. Schmidt and H. vander Schalie for the loan of material, and to Bengt Hubendick for the use of his manuscript notes which he had made on the genus *Pedipes*. My thanks are due to Dr. Champion and to Dr. Turner for reading the manuscript.

Genus *Pedipes* Férussac

Pedipes Férussac 1821, Tableaux Systématiques des Animaux Mollusques, Paris, p. 99 and 109 (p. 103 and 105 in the folio edition).

Carassa Gistel 1847 [1850] Handbuch der Naturgeschichte aller drei Reiche, Stuttgart, p. 555; Gistel 1848, Naturgeschichte Thierr., Stuttgart, p. 169. [This is only a substitute name for *Pedipes* Férussac.]

The shells are imperforate, small, seldom reaching 8 mm., rounded-ovate in outline and sculptured with incised spiral grooves. The whorls are few and the last one large. The aperture is constricted by the three plicae on the parietal wall or inner lip and the single, ridge-like tooth on the inner side of the palatal lip. Coloration ranges from yellowish brown to dark chocolate-brown. The foot is divided by a transverse groove. When the posterior portion is fixed the anterior part is extended forward and then the posterior part brought forward, thus allowing the animal to make short and rather rapid steps.

Type species, *Pedipes afra* Gmelin (= *P. pedipes* Bruguière), subsequent designation, Gray 1847.

Pedipes mirabilis Megerle von Mühlfeldt

Plate 76, figs. 1-3; Plate 77

Turbo mirabilis Megerle von Mühlfeldt 1816, Gesellschaft Naturforschender Freunde zu Berlin (Magazin) 8: 8, pl. 2, figs. 13a-b (locality unknown); non W. Wood 1828.

Pedipes quadridens Pfeiffer 1839, Archiv für Naturgeschichte 1: 357 (Cuba).

Pedipes globulosus C. B. Adams 1845, Proc. Boston Soc. Nat. Hist. 2: 12 (Jamaica).

Pedipes ovalis C. B. Adams 1849, Contributions to Conchology no. 3, p. 41 (Jamaica).

Pedipes tridens Pfeiffer 1854 [1855], Proc. Zool. Soc. London, p. 122 (Bermuda and Cárdenas, Cuba).

Pedipes globulus 'Petit' Pfeiffer 1856, Monographia Auriculaceorum Viventium 1: 71 (Insula Haiti).

Pedipes naticoides Stearns 1869 [1870], Proc. Boston Soc. Nat. Hist. 13: 108, text fig. (Rocky Point, Tampa Bay, Florida).

Pedipes insularis Haas 1950, Proc. Malac. Soc. London 28: 197, pl. 22, fig. 3 (Bermuda).

Description. Shell imperforate, small, variable in size, from 3 to 5 mm. (1/5 inch) in length, globose to globose-turbinate, usually sculptured and very solid in structure. Whorls 4 to 5 and strongly convex. Color light brown to a rather dark, reddish brown.

Spire extended moderately above the body whorl. Suture distinct. Aperture ovate to subovate with the outer edge thin but much thickened just within. Parietal area supporting three well developed plicae: two which are nearly uniform in size are built at right angles to and on the columella; the third and upper plica is much larger and built upon the body whorl. Outer lip supporting a ridge-like tooth which is directly opposite the central plica. This tooth extends backward a short distance within the aperture. Columella broad and straight. Sculpture consisting of numerous fine, incised, spiral grooves. Axial sculpture consisting of fine and irregular growth lines.

The radular teeth are extremely small and very numerous. The central tooth has a bifurcated base and a single denticle. The innumerable lateral teeth are straight-sided and have a simple denticle. The inner marginal teeth are about twice the width of the laterals and have four, long denticles, while the even broader outer marginals have six comb-like denticles. This radula is very close to those figured by Odhner (1925) for *Pedipes afra* Gmelin and *Plecotrema* [= *Laemodonta*] *clausa* Adams, and by Morton (1954) for *Marinula fiholi* Hutton. The illustration (Plate 77) was drawn at a magnification of 1290 \times .

length	width	(all adults)
5.0 mm.	4.0 mm.	Barbados, Lesser Antilles
4.5	3.5	Matanzas, Cuba
4.5	4.0	Port Salut, Haiti

Types. The original types of this species may not be in existence. The lectotypes of *P. ovalis* C. B. Ad., no. 177349 and *P. globulosus* C. B. Ad., no. 177347, are in the Museum of Comparative Zoology. Both came from Jamaica. The holotype of *P. naticoides* Stearns from Rocky Point, Tampa Bay, Florida is in the United States National Museum, no. 37598. The holotype of *P. insularis* Haas is in the Chicago Natural History Museum, no. 30171.

Pfeiffer's collection was purchased by Dr. Henry Dohrn and later given to the Museum in Stettin, Germany.

Remarks. The many names in the synonymy of this species are due to the variation existing between its unit populations. These names were based upon different stages of growth, or perhaps slightly different genetic strains, particularly affecting size. This is easy to understand when comparisons are made between two or more populations. Each population can be remarkably uniform simply because the entire population may have had its origin from a single individual or a single clutch of eggs. Thus, comparisons are made between groups in different periods of growth and these differences are quite striking. The type of *Pedipes naticoides* Stearns is a small, immature specimen of *P. mirabilis* von Mühlfeldt.

Range. Florida and Texas, Bermuda and south to Estado de São Paulo, Brasil. This

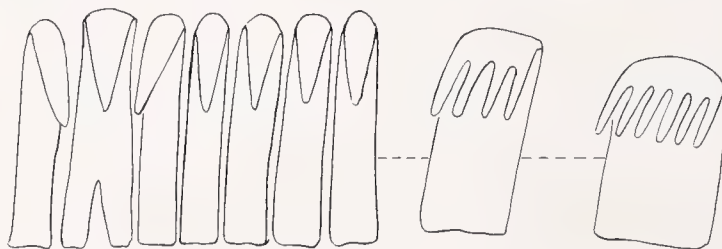


Plate 77. Radula of *Pedipes mirabilis* v. Mühlfeldt from a specimen from Cabo Rojo, Puerto Rico.

southernmost record is by Morretes (p. 122) and he listed it as *Pedipes afra* Gmelin (= *Pedipes pedipes* Bruguière). This is an Eastern Atlantic species and Morretes' record is very probably a misidentification for *Pedipes mirabilis* v. Mühlfeldt.

Specimens examined. FLORIDA: Lake Worth (J. S. Schwengel); Miami; Tavernier Key; Lower Matecumbe Key (all USNM); Plantation Key; Grassy Key; Crawl Key; Knights Key; Bahia Honda Key; Little Torch Key; Ramrod Key; Sugar Loaf Key (all D. & N. Schmidt); Boca Chica Key; Key West; Garden Key, Tortugas (all USNM); Tarpon Bay, Sanibel (MCZ); St. Petersburg (USNM; Edna Marcott). TEXAS: Port Aransas (Myra Taylor). BERMUDA: (MCZ; U of M; USNM). BAHAMA ISLANDS: Wilson City, Great Abaco (R. Robertson); Sand Bank, Crossing Bay and Sweetings Village, both Great Abaco (both MCZ); Mores Island (MCZ); Clifton Bluff, New Providence (MCZ); Mangrove Cay, Andros (USNM); Royal Island, Eleuthera (USNM); Governor's Harbour, Eleuthera (MCZ); Hog Cay, Exuma Island (R. Robertson); Cay Sal, Cay Sal Bank (USNM). CUBA: Vedado, Habana; Muelle de la Aduana, Matanzas; Cayo Francés, Caibarién; Chivera, Santiago (all Museo Poey); Penas Altas and Versailles, both Matanzas (both P. J. Bermudez). JAMAICA: Montego Bay; Jack's Bay and Robin's Bay; Kingston; Rio Cobre; Port Royal (all USNM). HISPANIOLA: Port Salut; Les Cayes; St. Louis; Aquin; Saltrou, all Haiti (all USNM); Cayo Chico, Santa Bárbara de Samaná (MCZ); Ciudad Santo Domingo (USNM), both Republica Dominicana. PUERTO RICO: Cabo Rojo and Humacao (both MCZ); Ensenada Honda, Culebra Island (USNM). VIRGIN ISLANDS: St. Thomas (USNM); Christiansted, St. Croix (G. Usticke); Guana Island, Tortola (M. Dewey). LESSER ANTILLES: St. Kitts; Barbados and Martinique (USNM); Guadeloupe (AMNH); Bequia Island, The Grenadines and Toco, Trinidad (both MCZ). COLOMBIA: Bahía de Savanilla (USNM).

Pedipes angulata C. B. Adams

Plate 78

Pedipes angulatus C. B. Adams 1852, Ann. Lyceum of Nat. Hist. New York **5**: 431 (Panama). Turner, R.D. 1956, Occ. Papers On Mollusks **2**: 31, pl. 10, fig. 6. Lectotype MCZ, no. 177345.

Pedipes lirata Binney 1860, Proc. Acad. Nat. Sci. Philadelphia, p. 154 (Cabo San Lucas, Lower California, [Mexico]); Binney 1865, Smithsonian Miscellaneous Collections, no. 143, p. 20, text fig. 21.

Description. Shell imperforate, small, reaching 7.4 mm. (about $\frac{1}{4}$ inch) in length, globose, sculptured and solid in structure. Whorls 5, strongly convex and shouldered. Color a uniform chestnut-brown. Spire extended a little above the body whorl. Suture distinct. Aperture ovate to subovate with the outer lip thin but much thickened below. Parietal area with 3 plicae, the lower two on the columella about equal in size, the upper one on the body whorl much larger. Outer lip with a single broad tooth below the shoulder. Columella broad and straight. Sculpture consists of numerous fine, incised spiral grooves. Axial sculpture of fine growth lines.

length	width	
6.5 mm.	5.0 mm.	Lectotype
7.4	5.1	Paratype

Types. The lectotype of *Pedipes angulata* is in the Museum of Comparative Zoology, no. 177345, from Panama (West Coast) probably from the vicinity of Panama City.

Additional paratypes from the same locality are in the Museum of Comparative Zoology, no. 177346. The holotype of *P. lirata* Binney is in the United States National Museum, no. 8567, from Cabo San Lucas, Baja California, Mexico.



Plate 78. *Pedipes angulata* C. B. Adams. Lectotype from Panama (West Coast) (14.1x). MCZ, no. 177345.

Remarks. *Pedipes angulata* C. B. Adams is close in its relationship to *P. mirabilis* von Mühlfeldt of the Western Atlantic. It differs by being larger, having a somewhat broader columella and in having the outer lip expanded or bell shaped. The sculpture appears to be the same in both species, as are the columellar and palatal teeth, but they are much larger in *P. angulata*. In addition, the whorls in *P. angulata* are slightly flattened.

Pedipes lirata Binney was based upon a single, slightly immature specimen.

Range. From southern California south to the Republic of Panama.

Specimens examined. MEXICO: Pichilique Bay; Santo Domingo; Magdalena Bay, all Baja California (all USNM). PANAMA: Taboga Island and Panama (both MCZ).

Genus *Laemodonta* Philippi

Laemodonta Philippi 1846, Zeitschrift für Malakozoologie 3: 98.

Plectotrema H. and A. Adams 1853 [1854], Proc. Zool. Soc. London 21: 120.

Laimodonta 'Nuttall' H. and A. Adams 1855, Genera of Recent Mollusca 2: 246, non Bronn 1847.

Laemadonta 'Adams' Carpenter 1861, Ann. Rept. Regents Smithsonian Inst. for 1860, p. 228 [error for *Laimodonta* H. and A. Adams].

Laimadonta 'Adams' Pease 1868, American Jour. Conchology 4: 101 [error for *Laimodonta* H. and A. Adams].

Plectotroma 'Adams' Weyenbergh 1875, Period. Zool. Buenos Aires 2: 288 [error for *Plectotrema* H. and A. Adams].

Enterodonta Sykes 1894, Jour. of Malacology 3: 73, new name for *Laimodonta* H. and A. Adams 1855, non Bronn 1847.

Shells ranging in height from 3 mm. to 9 mm., rounded, ovate in shape and sculptured with fine to coarse, spiral threads. The various species are brownish to brownish yellow in color. There are three plicae on the inner lip and one to three teeth on the outer lip. All are imperforate other than *L. cubensis* Pfr.

Type species, *Laemodonta striata* 'Adams' Philippi, monotypic (= *L. octanfracta* Jonas). The following are the original references to these two names:

Pedipes octanfracta Jonas 1845, Zeitschrift für Malakozoologie **2**: 169 (?Sandwich Islands [Hawaiian Islands]).

Auricula striata Philippi 1846, Zeitschrift für Malakozoologie **3**: 98 (Sandwich Islands [Hawaiian Islands]), non *Auricula striata* v. Martens 1824, non Anton 1839.

Hubendick (1956, p. 111) has advocated the continued use of *Plectotrema* H. and A. Adams 1854, rather than *Laemodonta* Philippi 1846, but gives no reason for so doing. *Laemodonta* was introduced twelve years earlier with a monotypic type designation, leaving no question as to the status of *Laemodonta*. Errors in spelling of *Laemodonta* may have brought about some confusion but the original author should hardly be penalized for this trouble.

Haas (1950, p. 199) mentions that he was the first to note that *Laemodonta* possesses a "hirsute periostracum." Garrett (1872, p. 219) described a *Plectotrema hirsuta* [= *Laemodonta*] from the Fiji Islands which is "garnished with short, curved hairs." This character, of course, may not occur in the young stages of all species in this genus but it should be expected.

Subgenus **Bullapex** Haas

Bullapex Haas 1950, Proc. Malacological Soc. London **28**: 199.

This single species in the subgenus *Bullapex* differs from other species in *Laemodonta* by having a large, white and inflated apex which is produced at nearly a right angle to the long axis of the shell. It has, in addition, a very small umbilical opening.

Type species, *Laemodonta cubensis* Pfeiffer, original designation.

Laemodonta (Bullapex) cubensis Pfeiffer Plate 79

Description. Shell usually finely umbilicate, small, being about 3.3 mm. (about $\frac{1}{8}$ inch) in length, ovate-conic, sculptured and rather thin in structure. Whorls 5 to 6 and flattened on the spire. Color a light straw-yellow, the apex being white. Apex enlarged and formed at nearly a right angle to the shell axis. Spire conic and moderately extended. Suture relatively indistinct owing to the spiral sculpture and the flattened whorls of the spire. Aperture auriculate with the outer lip simple and having two well developed teeth. Inner lip with three well developed teeth, two being on the parietal wall and one on the columella. Sculpture consisting of numerous fine, incised, spiral lines which are crossed by somewhat finer growth lines.

length	width	
2.5 mm.	1.6 mm.	Bahia Honda Key, Florida
3.3	1.8	" " " "

Types. The present location of the type of *Laemodonta cubensis* Pfeiffer is unknown. The Pfeiffer collection was purchased by H. Dohrn and later deposited in the museum in Stettin, Germany.

Remarks. This is the only species of *Laemodonta* to occur anywhere in the Atlantic and here it is limited to southern Florida, Bermuda, and the West Indies. The remaining species in this genus are all from the Indo-Pacific.

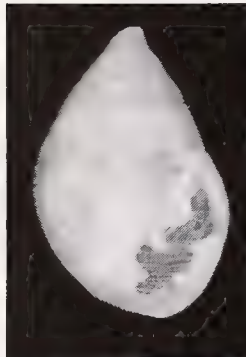


Plate 79. *Laemodonta cubensis* Pfeiffer. Bonefish Key, Lower Florida Keys (9.4x).

Laemodonta cubensis Pfr. probably has a wider distribution than is now known as its small size and type of habitat make it difficult to find.

This species is found along the upper strand line under broken coral, sea weed and other debris.

Range. South Florida Keys, Bermuda and the West Indies south to Barbados.

Specimens examined. FLORIDA: Key Largo (MCZ); Crawl Key; Bahia Honda Key; Little Torch Key; Ramrod Key (all D. and N. Schmidt); Bonefish Key (T. McGinty). BERMUDA: (MCZ). BAHAMA ISLANDS: Wilson City and south of Witch Point (both R. Robertson); Sand Bank, Crossing Bay; Mores Island (both MCZ), all Great Abaco; Hog Cay, Exuma Cays (R. Robertson). CUBA: Vedado, Habana (Museo Poey).

World Catalogue of the Genus Pedipes

adansonii de Blainville, **Pedipes:** 1824, Dictionnaire des Sciences Naturelles **32:** 246 [refers to Adanson 1757, Histoire Naturelle du Sénégal, pl. 4, fig. 4]. Is *Pedipes pedipes* Bruguière.

affinis Férussac, **Pedipes:** 1821, Tableaux Systématiques des Animaux Mollusques. Paris, p. 109 (L'Ile de France [Mauritius]). Is a *Laemodonta*.

afer 'Gmelin' Pfeiffer, **Pedipes:** 1856, Monographia Auriculaceorum Viventium **1:** 68 (Gorée Id. [Dakar] Sénégal). Is *Pedipes pedipes* Bruguière.

afra Gmelin, **Helix:** 1791, Systema Naturae, 18 ed., **6:** 3561 (Sénégal). Is *Pedipes pedipes* Bruguière.

angulatus C. B. Adams, **Pedipes:** 1852, Ann. Lyceum of Nat. Hist. New York **5:** 431 (Panama [West Coast]). Lectotype MCZ, no. 177345.

biangulatus Jaeckel, **Pedipes**: 1927, *Zoologischer Anzeiger* **70**: 48, text figs. 1-2 (Santa Catalina [Island] California). Is *Marinula unisulcatus* Cooper.

Carassa Gistel: 1847 [1850], *Handbuch der Naturgeschichte aller drei Reiche*, Stuttgart, p. 555; Gistel 1848, *Naturgeschichte des Thierreichs*, Stuttgart, p. 169. [This is only a substitute name for *Pedipes* Férussac¹.]

coniformis de Blainville, **Pedipes**: 1824, *Dictionnaire des Sciences Naturelles* **32**:246 [refers to *Tableau Encyclopédique et Méthodique* 1816, **3**: pl. 459, figs. 2a-b, which is a *Melampus*].

crassidens Bavay, **Pedipes**: 1920, *Bull. Mus. Nat. D'Hist.*, Paris, **26**: 638, text. fig. (Tamara Island [Los Islands], French Guinea).

deschampsii Ancey, **Pedipes**: 1887, *Bull. Soc. Malac. France* **4**: 283 [not figured] (Aden).

dohrni d'Ailly, **Pedipes**: 1896, *Bihang Svenska Vet. Ak. Handl.* **22**: 118 [not figured] (Jonje, Cameroons).

elongatus Dall, **Pedipes**: 1885, *Proc. United States Nat. Mus.* **8**: no. 17, p. 279, pl. 18, fig. 4 (Marco, Florida). Is a *Marinula*.

forestieri Montrouzier, **Pedipes**: 1864, *Jour. de Conchy.* **12**: 41; 261, pl. 10, fig. 1 (Art Island, New Caledonia). Is a *Marinula*.

globulosus C. B. Adams, **Pedipes**: 1845, *Proc. Boston Soc. Nat. Hist.* **2**: 12 (Jamaica). Is *Pedipes mirabilis* v. Mühl. Lectotype MCZ, no. 177347.

globulus 'Férussac' H. and A. Adams, **Pedipes**: 1884 [1885], *Proc. Zool. Soc. London*, p. 36 [nomen nudum].

globulus 'Petit' Pfeiffer, **Pedipes**: 1856, *Monographia Auriculaceorum Viventium* **1**: 71 (Insula Haiti). Is *Pedipes mirabilis* v. Mühl.

granum Morelet, **Melampus**: 1872, *Ann. Mus. Civico di Storia Nat. di Genova* **3**: 205, pl. 9, fig. 14 (I'ile Schech Said, Abyssinia [Sheik Said, Massaua, Eritrea]). Is a *Pedipes*.

inaequalis 'C. B. Adams' H. and A. Adams, **Pedipes**: 1853 [1854]. *Proc. Zool. Soc. London*, p. 122 [nomen nudum].²

insularis Haas, **Pedipes**: 1950, *Proc. Malac. Soc. London* **28**: 197, pl. 22, fig. 3 (Bermuda). Is *Pedipes mirabilis* v. Mühl. Holotype, Chicago Nat. Hist. Mus., no. 30171.

jouani Montrouzier, **Pedipes**: 1862, *Jour. de Conchy.* **10**: 244, pl. 9, fig. 11 (Baie Boisee, New Caledonia).

¹ I have not seen these two papers but through the kindness of Dr. Charles Wurtz I received typewritten copies of both paragraphs containing *Carassa*. The wording in both papers is the same.

² No such species was described by C. B. Adams. Apparently C. B. Adams exchanged material which had his manuscript names. Later he changed these names before publication or else discarded them entirely.

leoniae Ancey, **Pedipes**: 1887, Bull. Soc. Malac. France **4**: 286 [not figured] (Aden).

lirata Binney, **Pedipes**: 1860, Proc. Acad. Nat. Sci. Philadelphia, p. 154 [not figured] (Cabo San Lucas, Lower California); Binney 1865, Smithsonian Misc. Collections, no. 143, p. 20, text fig. 21. Is *Pedipes angulata* C. B. Adams.

liratulus Kobelt, **Pedipes**: 1901, Conchylien-Cabinet (2) **I**: pt. 16, p. 297, pl. 33, figs. 20–21 (Australia?). Probably is a *Marinula*.

mirabilis Megerle von Mühlfeldt, **Turbo**: 1816, Gesellschaft Naturforschender Freunde zu Berlin (Magazin) **8**: 8, pl. 2, figs. 13a–b (locality unknown).

naticoides Stearns, **Pedipes**: 1869 [1870], Proc. Boston Soc. Nat. Hist. **13**: 108, text fig. (Rocky Point, Tampa Bay, Florida). Is *Pedipes mirabilis* v. Mühl. Holotype USNM, no. 37598.

occidentalis 'Pfeiffer' Paetel, **Pedipes**: 1889, Catalog der Conchylien-Sammlung **2**: 381 [nomen nudum].

octanfracta Jonas, **Pedipes**: 1845, Zeitschrift für Malakozoologie **2**: 169 (Sandwich Islands? [Hawaiian Islands]). Is a *Laemodonta* according to Jickeli (1872, Nachrichtenblatt Malak. Gesell. **4**: 65).

ovalis C. B. Adams, **Pedipes**: 1849, Contributions to Conchology, no. 3, p. 41 (Jamaica). Lectotype, MCZ, no. 177349. Is *Pedipes mirabilis* v. Mühl.

ovulus Férussac, **Pedipes**: 1821, Tableaux Systématiques des Animaux Mollusques, Paris, p. 109 (locality unknown).

Pedipes Férussac: 1821, Tableaux Systématiques Animaux Mollusques, Paris, pp. 99 and 109 [103 and 105 in folio edition]. Type species, *Pedipes afra* Gmelin [= *Bulimus pedipes* Bruguière].

pedipes Bruguière, **Bulimus**: 1789, Encyclopédie Méthodique **1**: 340 (Gorée Island [Dakar], Sénégal).

philippinica v. Möllendorff, **Pedipes jouani**: 1893, Bericht der Senckenbergischen Natur. Gesell., p. 104 (Limansaua Id. [Limasaua Id., Leyte Id.] Philippines).

quadridens Pfeiffer, **Pedipes**: 1839, Archiv für Naturgeschichte **1**: 357 [not figured] (Cuba). Is *Pedipes mirabilis* v. Mühl. (Pfeiffer 1856, Mono. Auriculaceorum Viventium **1**: 70).

sandwicensis Pease, **Pedipes**: 1860, Proc. Zool. Soc. London, p. 146 (Sandwich Islands [Hawaiian Islands]). Holotype, MCZ, no. 74813.

tornatilis de Blainville, **Pedipes**: 1824, Dictionnaire des Sciences Naturelle **32**: 245 [refers to Tableau Encyclopédique et Méthodique 1816, **3**: 452, figs. 3a–b which is an *Actaeon*].

tridens Pfeiffer, **Pedipes**: Proc. Zool. Soc. London 1854 [1855], p. 122 (Bermuda). Is *Pedipes mirabilis* v. Mühl.

unisulcata Cooper, **Pedipes**: 1867, Proc. California Acad. Sci. **3**: 294, text fig. 29 (San Pedro, California). Is a *Marinula*. Lectotype, here selected, Univ. of California, no. 12578; paratype, MCZ, no. 74812.

REFERENCES

- Garrett, A. 1872. American Jour. Conchology **7**: 219.
Haas, F. 1950. Proc. Malac. Soc. London **28**: 197-199.
Hubendick, B. 1956. Proc. Malac. Soc. London **32**: 110-126.
Meyer, K. O. 1955. Archiv für Molluskenkunde **84**: 1-43.
Morretes, F. Lange de 1949. Arquivos do Museu Paranaense **7**: 122.
Morton, J. E. 1954. Proc. Zool. Soc. London **125**: 127-168.
Odhner, Nils Hj. 1925. Arkiv för Zoolog K. Svenska Vetenskapsakademien **17A**: no. 6, pp. 1-15.
Thiele, J. 1931. Handbuch der Systematischen Weichtierkunde **1**: pt. 2, p. 463.
Turner, R. D. 1956. Occasional Papers On Mollusks (Harvard Univ.) **2**: 21-136.

* * * *

The Portland Catalogue

Lightfoot, John 1786: A Catalogue of the Portland Museum, Lately the Property of the Duchess Dowager of Portland, Deceased. London, pp. 8+194. After the death of the Duchess in 1785 her large collection of natural history objects was sold at auction. This necessitated a catalogue of some magnitude. Many of the shells listed were new and the names were given to them by Daniel Solander. The authorship of these names was indicated by the letter "S," as explained on page 6 of the introduction. Such names by Solander which are followed by a reference to either a previously published description or figure are considered validly introduced names. Names not followed by such a reference are considered nomina nuda.

For many years the editorship of the Portland Catalogue has been open to question. Recently, S. P. Dance 1962, has given documentary evidence to indicate that John Lightfoot was the real compiler, or in reality the editor, of this catalogue. This in no way, however, changes the authorship of the names which were introduced validly by Solander and so credited by Lightfoot. In the Preface of the Portland Catalogue it states:

"It was indeed the Intention of the enlightened Possessor to have had *every unknown* Species described and published to the World; but it pleased God to cut short the Design, not only by the Death of the ingenious Naturalist employed by her for that Purpose* [* Dr. Solander, given in a footnote] but, in short Time afterwards, to the great and irreparable Loss of Science, by her own also."

Dance, in reference to a few discrepancies which exist between the Portland Catalogue

and an original manuscript of Solander, considers these to be the work of Lightfoot. He states: "These discrepancies indicate that a number of the names bearing an 'S' did not originate with Solander and, to avoid confusion, it may be preferable to attribute all of them to Lightfoot." This is entirely circumstantial evidence and in no way proves that Lightfoot was the author of these discrepancies. The few discrepancies which exist between the Portland Catalogue and Solander's unpublished manuscript are not in any way proof that these changes were not made by Solander.

Dance remarks (page 32), "As Solander died in 1782 he could not have seen the first volume of Martyn's work which appeared in 1784." This, of course, is true so far as it concerns the completed volumes, but it does not mean that Solander did not see many of the plates made during the process of Martyn's work and, as such, used them as references. In the Introduction to the Universal Conchologist, Martyn states: "And here the Author begs permission to mention, as a tribute of justice to the liberality of the possessors, the several collections in this kingdom to which he is indebted for some of the more beautiful objects in these volumes. Among these, the first praise is confessedly due to the superb collection of the Duchess Dowager of Portland; so rich a display in the number as well as rarity and perfection of these subjects, together with every other species of marine productions, perhaps is not to be equalled." This would certainly indicate that both Solander and Martyn had known one another.

Daniel Carl Solander was born in Norrland, Sweden in 1736. He studied at Upsala and was a student of Linné. In 1760 he was engaged by the British Museum as an Assistant, and in 1865 became an Assistant Keeper, a title equivalent to Curator as now used to indicate the head of a museum department. Iredale (1916) did not state what department, but it was most certainly in Botany. In 1768, associated with Joseph Banks, he sailed with Captain Cook to observe the transit of Venus in the South Pacific. Solander was primarily a botanist, but he also possessed a broad knowledge of Zoology, particularly in the fields of Ornithology and Conchology, and this latter interest brought him in contact with the Duchess of Portland. He died at the early age of 46, in 1782.

Iredale has given a list of all of the valid names and their references as well as other data relative to this catalogue and about Dr. Solander.—W. J. CLENCH

REFERENCES

- Dall, W. H. 1921. Species Named in the Portland Catalogue: 1, American, Nautilus 34: 97-100; *ibid.* part 2, pp. 124-132.
- Dance, S.P. 1962. The Authorship of the Portland Catalogue (1786). Journal of the Society for the Bibliography of Natural History 4: 30-34.
- Iredale, T. 1916. Solander as a Conchologist. Proc. Malacological Soc. of London 12: 85-93.
- Lightfoot, J. 1786. A Catalogue of the Portland Museum, Lately the Property of the Duchess Dowager of Portland. London, pp. 8+194.
- Martyn, T. 1784. The Universal Conchologist. London, Vol. 1; second edition 1789.

JOHNSONIA

Published by
THE DEPARTMENT OF MOLLUSKS
Museum of Comparative Zoölogy, Harvard University
Cambridge, Massachusetts

FEBRUARY 13, 1964

VOLUTIDAE

VOL. 4. NO. 43

THE SUBFAMILIES VOLUTINAE, ZIDONINAE, ODONTOCYMBIOLINAE AND CALLIOTECTINAE IN THE WESTERN ATLANTIC

BY
WILLIAM J. CLENCH AND RUTH D. TURNER

In *Johnsonia*, numbers 22 and 32, the senior author monographed the subfamily Scaphellinae. The present number considers four additional subfamilies which includes most of the remaining genera in the Western Atlantic Volutidae. Such genera as *Lyria*, *Enaeta* and *Volutomitra* will be considered later when more material is available for study.

Few if any families among the marine gastropods show a greater diversification in the structure of the radula, the shell, and the soft anatomy than the Volutidae. Feeding habits most certainly have had an effect upon changes in the basic plan of the radula. So far as is known, all members of the Volutacea are predaceous or are scavengers feeding on dead animal matter.

A striking example of the problems inherent in this family is illustrated by *Adelomelon ancilla* (Solander) and *Odontocymbiola magellanica* (Gmelin). These two species have the same range (Carcelles, 1944) and have very similar shells but very different radulae. It is impossible to state whether they are allopatric or sympatric. The fact that these two species could have been brought up in a single dredge haul does not mean they occupied the same ecological niche.

The shell characters of *Odontocymbiola americana* (Reeve) are close to those of *Aulicina vespertilio* (Linné) of the Western Pacific, yet the radulae are very different, a character which places these two species in different subfamilies: *O. americana* in the Odontocymbiolinae and *A. vespertilio* in the Zidoninae. The radulae of about 55 species are known, which is about 25 percent of the number of species in the Volutidae.

By sectioning the shells it can be seen that the number of columellar plicae varies within the species but remains constant in any one specimen throughout its life, at least among the species we have examined. Specimens sectioned include *Voluta musica* Linné (figured on Plate 80), *Volutocorona imperialis* (Solander) and *Scaphella junonia* (Shaw).

Various systems have been used in the classification of the Volutidae: the adult shell, the characters of the embryonic shell, the extent to which the mantle covers the shell, and the radula. Of all of these systems, the radula appears to be the best single structure upon which a more natural classification can be based; the shell, the protoconch and other structures being secondary in an evaluation of relationships.

Lahille (1895) made a study of the Argentinian species of the Volutidae and figured

most of the variations exhibited by the shells. Unfortunately, he gave names to these variations. It appears, however, that the variations he selected were a mixture from several localities, so that no biological inferences can be made from his study. Subsequent authors have ignored rather than overlooked this work, or at best have given it only casual mention.

Pilsbry and Olsson (1954) summarized the historical aspects of the classification in this family. The earliest classifications were based entirely upon the shell morphology. J. E. Gray (1858) was among the first to base the major classification upon the type of radula. Dall (1890) attempted a new classification based upon the various types of protoconchs, such as trochiform or bulbous, large or small, pupiform or planorboid. The differences in this morphological structure brought together unrelated species and separated those now known to be closely related. Thus, *V. musica* Linné and *V. ebraea* Linné were placed in different species groups, but they are now known to belong to the same genus, based upon the radulae, shell morphology and soft anatomy. Conversely, Dall's classification brought together *Scaphella junonia* (Shaw) and *Adelomelon brasiliiana* (Lamarck). These two species are now placed in different subfamilies.



Plate 80. *Voluta musica* Linné (about 2x). "This *Voluta* was used by Professor Peck to illustrate his lectures in Cambridge College, Mass. It was given by Mrs. Peck to Professor Th. Nuttall and by him to the present donor. August 1874. S. S. Haldeman." (From the original label.)

Mr. S. S. Haldeman, Professor of Natural Sciences at the University of Pennsylvania, presented this specimen to John G. Anthony, then in charge of the mollusk collection at the Museum of Comparative Zoology. William Dandridge Peck was Professor of Natural History at Harvard University between 1805 and 1822.

Cossmann (1899) proposed still another classification based upon all of the various shell characters: the columellar plicae, the shape of the siphonal canal, and the degree of development of the fasciole. This was an improvement over the classification of Dall, as relationships were based upon several different characters. It must be remembered, however, that both Dall and Cossmann were attempting to produce a classification by which the fossil forms could be brought into some semblance of order.

The most recent review of the Volutidae is that of Pilsbry and Olsson 1954. In this report they outlined the subfamilies, several of which they described as new. Their classification is based mainly upon the shell and radula.

The fossil history of the Volutidae in the Western Atlantic is extensive. Basic studies by Dall (1889, 1890 and 1907), Cossmann (1899), Ortmann (1902), von Ihering (1907) and Feruglio (1933), as well as others, cover this subject in considerable detail. According to Dall (1900) the Western Atlantic Volutidae first appeared in the Cretaceous and have continued undiminished to Recent times. According to Weaver (1963) there are approximately 200 living species throughout the world. Most of these species occur in tropical waters, mainly below low water line, and a few species have invaded very deep water. Clarke (1962) lists four members of the Volutidae which have been dredged in depths deeper than 1000 fathoms.

ACKNOWLEDGMENTS

We are indebted to many friends who have aided us in this study. R. Tucker Abbott and Robert Robertson of the Academy of Natural Sciences of Philadelphia and H. A. Rehder and Joseph Rosewater of the United States National Museum were generous in the loan of specimens. Clifton S. Weaver of Honolulu was most generous in the gift and loan of specimens from his fine collection of this family. We are grateful to J. J. Parodiz of the Carnegie Museum, Pittsburgh, for the many helpful discussions we had on the volutid species found in Argentina.

Preserved specimens for anatomical work were received from M. A. Klappenbach of the Museo de Historia Natural, Montevideo, and Eliseo Duarte also of Montevideo, from Bernard Kursch of the Instituto de Quimica Agricola, Rio de Janeiro, E. de Carvalho Rios of the Museu Oceanográfico de Rio Grande, Rio Grande do Sul, Brasil and Carl T. Young of the Carroll High School, Corpus Christi, Texas. Without this material it would have been impossible to understand the anatomy of the subfamilies or, in some cases, to allocate species to their proper genera.

We wish to thank D. F. McMichael of the Australian Museum for the use of notes on the types of the Western Atlantic volutids which he had made during his visit at the British Museum and E. H. Ureta of Montevideo, Uruguay for the typewritten copy of his paper on the Volutidae which he presented at the Zoological Congress in São Paulo, Brasil in 1962.

As usual, members of the department have been helpful in reading the manuscript, particularly R. W. Foster to whom we are also grateful for the timely receipt of new material obtained on a recent trip to Brasil.

NOTES ON THE ANATOMY

The external morphology of the animal of a number of volutes has been figured and described chiefly by Quoy and Gaimard (1832), Gould (1856) and d'Orbigny (1847).

The animal, as shown on Plates 90 and 104, is characterized by having a large broad foot which is usually highly colored, at least on the dorsal surface. The operculum, when present, is small, elliptical, and set on a small pad at a right angle to the long axis of the foot. The head is short, broad and flattened, usually having a large central lobe and two lateral lobes which may be produced either in front of or behind the tentacles. The tentacles are short, flattened and somewhat triangular in shape. The eyes, when present, are very small and located near the base of the tentacles. The proboscis, which can be introverted and drawn completely within the body cavity, is protruded from beneath the flattened head lobes. The siphon is a large muscular organ and is characterized by having one (Scaphellinae) or two lobes at the base as shown for several species on Plate 83.

Male specimens are readily distinguished by the presence of the intromittent organ or penis. In the *Odontocymbiolinae* it is large, carried folded back over the visceral hump completely within the mantle cavity. The vas deferens leading to it is embedded in the body wall as in *Odontocymbiola americana* (Plate 81).

In *Adelomelon ancilla* (according to Woodward, 1900, p. 118), *A. riosi* and *V. vesperilio* (all *Zidoninae*), the penis is relatively small and usually not folded back over the visceral hump. The opening of the vas deferens is high in the mantle cavity and an open groove leads from it to and along the ventral edge of the penis. In *Voluta ebraea* (*Volutinae*) the penis is broad, flattened, with a large, tapered, terminal papilla and the vas deferens is embedded in the body wall. Unfortunately in the material we had for study most of the specimens were females, but it would appear that the size and shape of the penis and its means of connection with the testes may prove of importance in the higher classification of this family.

In this study the soft anatomy was examined for nine different species and a total of eighteen specimens. Unfortunately all animals were not well preserved so that detailed comparisons cannot be made in all cases. Because of the limited number of specimens, it was impossible to judge the range of variation exhibited by any one species or to be sure that the specimen examined was normal and typical for the species. Differences, however, were found in the arrangement of the digestive gland which appear to be consistent within species groups, and these agree with the subfamilies created on the basis of shell and radular characters.

The general morphology of *Voluta musica* Linné has been described by Pace (1902) and *Voluta ancilla* Solander by Woodward (1900). *Odontocymbiola americana* has not previously been studied, so it is the anatomy of this species which is illustrated in detail here. Comparisons will be made with this species.

Because of the tremendous size of the foot and the columellar muscle, it was found that the animal could be more readily dissected by cutting through the mantle posteriorly (as close as possible to the columellar muscle) to the posterior end of the mantle cavity and then transversely, but without cutting through the intestine or oviduct, so that all the organs of the pallial or mantle cavity could be turned over and laid out to the left of the animal. This reveals the ventral surface of the large siphon with the lobes at the base and, just posterior to them, the large bipectinate osphradium and the gill. The hypobranchial mucous gland, the intestine, and the renal pore are now at the left. In the female the large swollen oviduct parallels the intestine and its opening is close to the anus. The large intromittent organ of the male is situated on the visceral hump just behind the right head lobe. In all of the characters mentioned above, the *Volutidae* resemble other *rachiglossate* species.

In order to examine the organs of the visceral hump a median incision was made through the head and over the hump and then laterally on both sides at the anterior and posterior areas of the animal. The dorsal wall of the body cavity was then folded to the sides and pinned back or cut off. If the proboscis, or introvert as it is often called, was retracted at the time the animal died, it appears as a large, oval, muscular mass at the anterior end of the body cavity. Just posterior to this are the racemose and tubular sali-

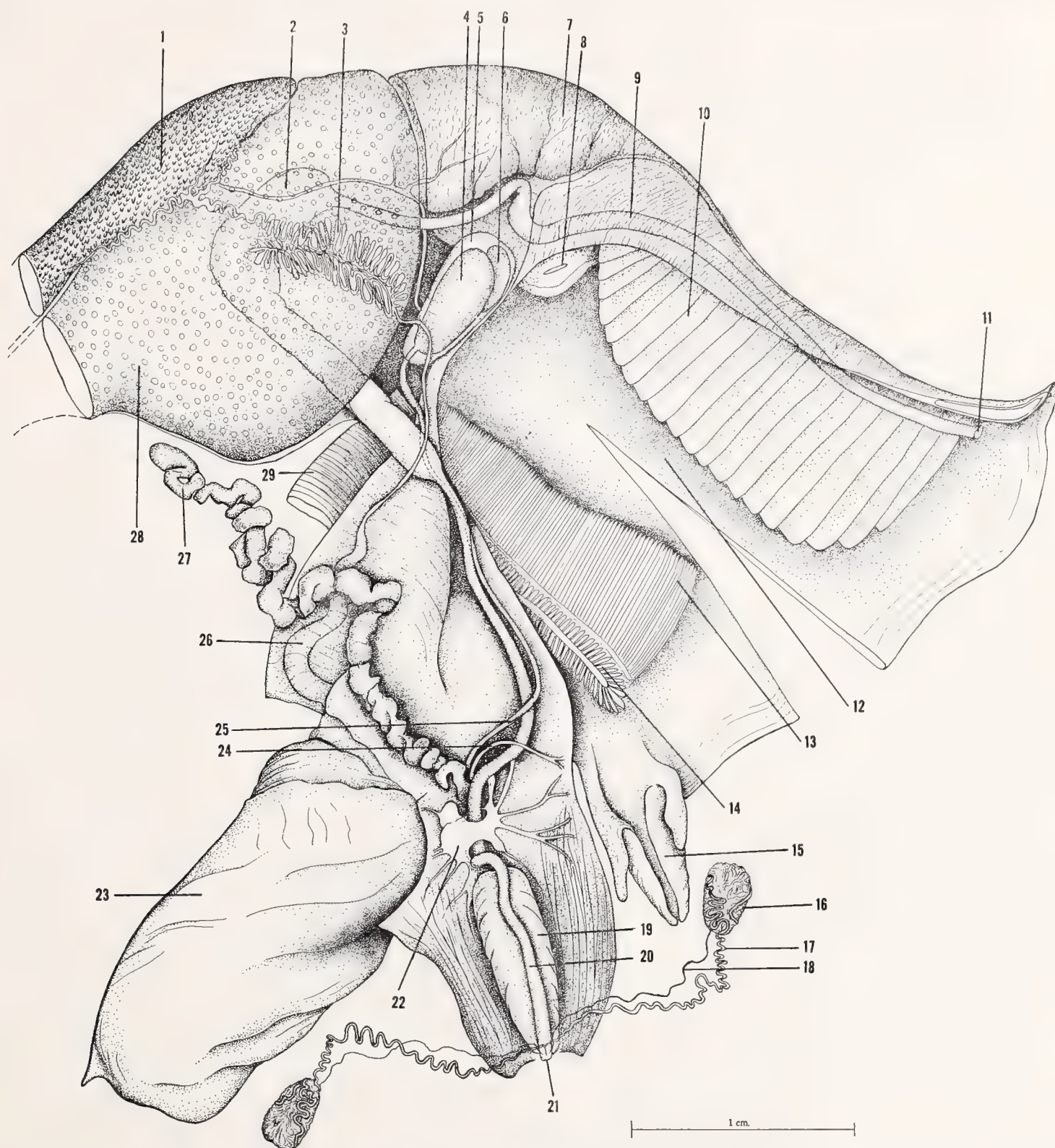


Plate 81. Semi-diagrammatic illustration of the anatomy of *Odontocymbiola americana* Reeve. 1, Testes. 2, Stomach. 3, Vas deferens. 4, Ventricle. 5, Pericardial cavity. 6, Auricle. 7, Kidney. 8, Renal opening. 9, Intestine. 10, Hypobranchial gland. 11, Anus. 12, Mantle cavity. 13, Gill. 14, Osphradium. 15, Siphon with two equal basal lobes. 16, Racemose salivary gland. 17, Tubular salivary gland. 18, Duct of the racemose salivary gland. 19, Buccal mass. 20, Esophagus. 21, Mouth. 22, Nerve ring. 23, Penis. 24, Supra-esophageal nerve. 25, Anterior aorta. 26, Vas deferens embedded in body wall. 27, Gland of Leiblein. 28, Digestive gland. 29, Columellar muscle (cut end).

vary glands and the large, convoluted oesophageal caecum or gland of Leiblein. The convolutions of the gland of Leiblein are tightly bound together by a tough, closely adhering connective tissue, and it has the appearance of an irregular, whitish, glistening ball. In order to study the relationship of the organs it was necessary to separate them. The connective tissue of the gland of Leiblein was removed, the gland uncoiled and pinned to the side. It is much larger than the esophagus into which it opens just posterior to the circumesophageal nerve-ring. Partially covering the nerve-ring and the posterior end of the introvert are the two paired salivary glands. These were not disturbed until the proboscis had been opened. As the proboscis is folded inward upon itself, an incision through the outer wall reveals its anterior end. If the specimen was soft and flexible, the proboscis could be lifted up and stretched forward into its normal feeding position, but with hardened animals it was necessary to make a second incision into the anterior end of the proboscis and to tease away the muscles holding the esophagus and buccal mass, taking care not to injure the ducts of the salivary glands which extend the length of the proboscis. The two pairs of salivary glands were then easily distinguished. The racemose glands in *ebraea* and *musica* (subfamily Volutinae) appear as large white, branching, 'fluffy' organs with short, wide ducts set at right angles to the esophagus just anterior to the nerve-ring (Plate 82). At the point of attachment to the esophagus the ducts diminish in size and extend forward along the sides of the esophagus, becoming extremely fine at the anterior end. Being bound with the esophagus, they are hardly distinguishable from the fine longitudinal muscles. The ducts open into the buccal cavity ventrally near the opening to the esophagus. The tubular salivary glands are long, narrow, convoluted, ribbon-like, and yellowish in color. In *musica* and *ebraea* they are completely free from the racemose glands and when the proboscis is extended they lie completely within it. When it is retracted, the posterior ends of the tubular gland are free in the body cavity. At the posterior end of the introvert, the tubular glands come to lie under the esophagus and extend anteriorly as greatly convoluted tubes which decrease gradually in size. At the posterior end of the buccal mass they unite and then, as a single, very fine duct, continue forward beneath the radular sac and enter the floor of the mouth anterior to the odontophore (Plate 82).

In *riosi*, *brasiliانا*, *dufresnei* and *ancilla* (subfamily Zidoninae) the racemose glands are large, irregularly shaped, rather compact organs whose branching structure is not readily evident. They are connected by short, fine ducts to the side of the esophagus in a manner similar to that found in *ebraea*. The tubular glands in this group of species are loosely connected with the racemose gland, the posterior ends of the tubular gland usually extending beyond them posteriorly. The convolutions, however, of the tubular glands can easily be "unwound" and separated from the racemose gland, and they are then found to extend forward in a manner similar to those of *ebraea*, though they are far more convoluted at the anterior end and join to form a single tube anterior to the midpoint of the buccal mass. The proximity of the union to the mouth varies with the species, though none unite as close to the mouth as in *magellanica* and *americana* (Plate 82). In *beckii*, which also belongs to this group, the racemose gland is moderately compact, and the tubular salivary gland in the one poor specimen available did not appear to wind closely around it. The tubular gland in this species is very long and extremely convoluted.

In *americana* and *magellanica* (subfamily Odontocymbiolinae) the racemose glands have become very compact and the tubular glands so closely attached that the two appear

as a single gland. The ducts of the racemose gland are fine throughout their length and terminate in the normal position but, instead of becoming attached to the wall of the esophagus, they parallel the ducts of the tubular glands until the latter unite at the anterior end of the buccal mass and the single duct enters the floor of the mouth anterior to the odontophore (Plate 82).

After the esophagus transverses the nerve-ring and gives off the gland of Leiblein, it continues around the columellar muscle and then becomes slightly enlarged to form the stomach which is imbedded in the digestive gland. The stomach is strongly fluted internally and ducts of the digestive gland open into it. The size and shape of the stomach, the walls of which are thin and non-muscular, appear to vary, depending on the contents. For the specimens dissected it was noted that, if the stomach was empty it was only slightly greater in diameter than the esophagus, but it was conspicuously enlarged in those which were full. Unfortunately, not enough specimens of any one species could be studied to prove this point and the stomach contents were too fragmentary to recognize, except in the case of *A. riosi* which was feeding on *Astropecten*.

In *Odontocymbiola americana* the convoluted portion of the vas deferens lies on the surface of the digestive gland. It emerges from the convolutions at the base of the gland and extends forward around the columellar muscle and enters the pallial cavity where it is imbedded in the muscular body wall and runs forward to the base of the penis. Within the penis the vas deferens winds back and forth until it reaches the penis papilla where it opens. According to Woodward (1900, p. 118) the opening of the vas deferens in *ancilla* is high up in the mantle cavity and a long groove extends from it to the penis which is also grooved. Unfortunately, so few male specimens were available for study the importance of these organs for systematic work could not be determined.

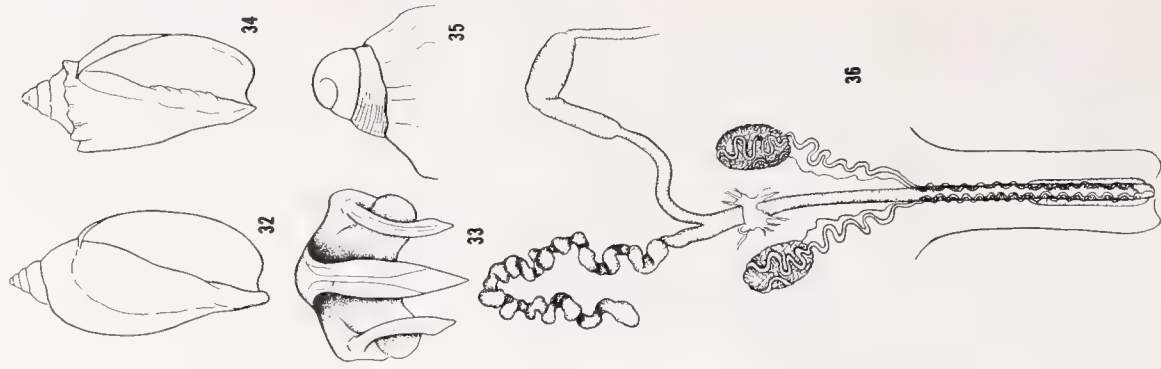
The nervous system for all species studied showed the maximum concentration of the ganglia in the circumesophageal nerve-ring, similar to that figured by Woodward (1900).

The radulae of the Volutidae are characteristically composed of a single row of powerful rachidian teeth. The Western Atlantic species discussed in this report may be arranged in three groups based on the structure of the teeth. The most common is the typical three-pronged tooth as illustrated for *riosi*, *brasiliانا*, *dufresnei*, *ancilla* and *beckii* (subfamily Zidoninae). The second type, exemplified by *musica* and *ebraea* (subfamily Volutinae), has a broadened tooth with several denticles all on the same level, the outer ones being the largest. The third group, including *americana* and *magellanica* (subfamily Odontocymbiolinae), has the denticles strongly hooked or fang-like (Plate 82).

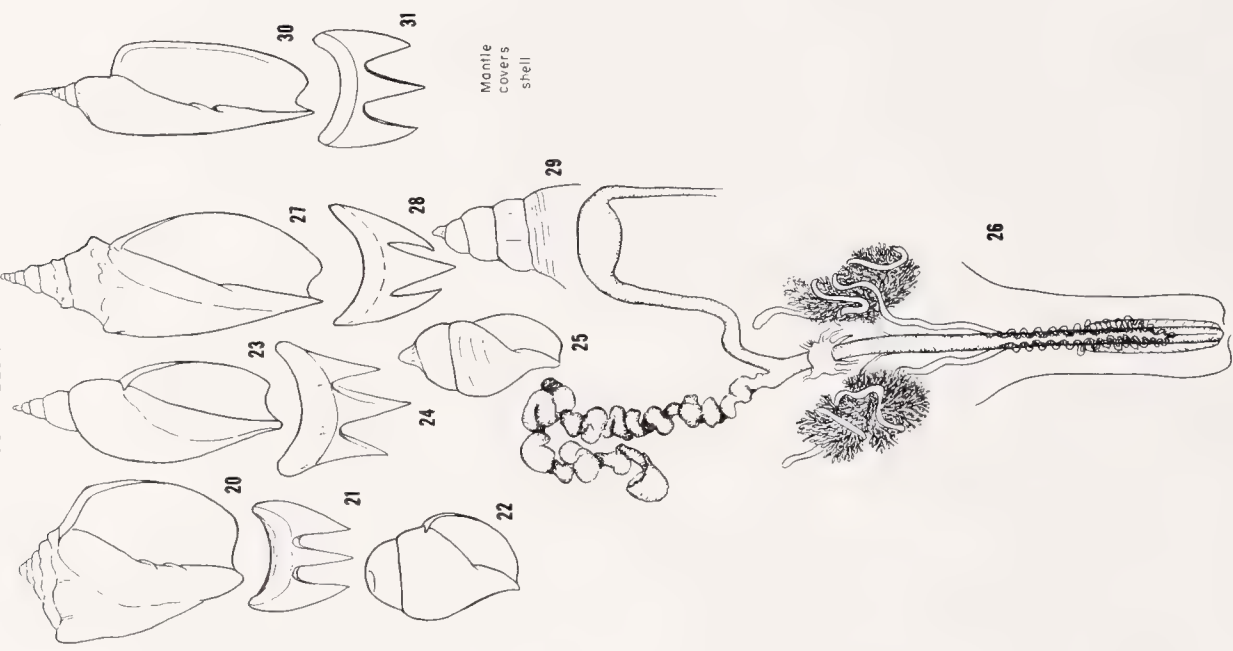
Thus it can be seen that the radular characters agree with those of the soft anatomy. It may be noted that *musica* and *ebraea* are further differentiated by having unequal lobes at the base of the siphons, a cleft in the central head lobe, and an operculum which is set on an opercular pad.

A fourth subfamily, the Scaphellinae, was monographed in *Johnsonia* 2: 41-60; 376-380 and, as was shown at that time, the radulae are characteristic. They consist of rachidian teeth only and these may be broadly to narrowly Y-shaped with a large central denticle while the lateral denticles are reduced in size or entirely lacking (see Plate 82). Recent examination of the soft parts of *Scaphella florida* Clench and Aguayo and *Aurinia kieneri* Clench has shown several differences between this subfamily and those considered in this paper. The head is bilobed in front by a deep cleft between the tentacles, which are merely lateral extensions of the lobes. The siphon has only a single basal lobe on

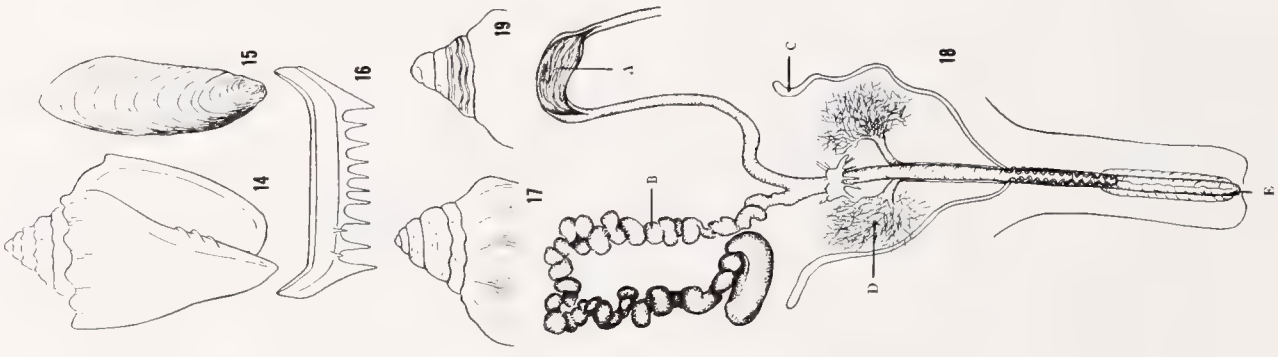
ODONTOCYMBIOLINAE
ODONTOCYMBIOLA



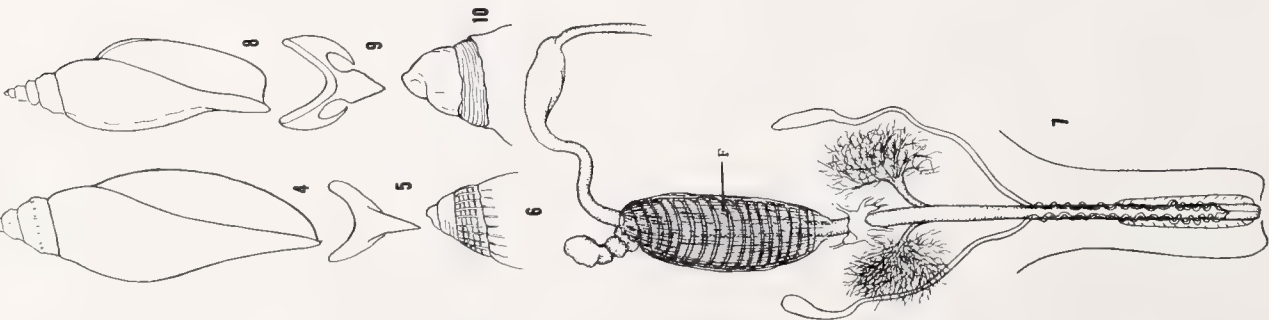
ZIDONINAE
ADELOMELON
ZIDONA



VOLUTINAE
VOLUTA



SCAPHELLINAE
AURINIA



SCAPHELLA



the left side close to the head when the animal is viewed dorsally. The racemose gland is "fluffy" as in *musica*; the tube glands are free, swollen at the distal end and not nearly as convoluted as in other species examined, their union very far towards the anterior. The gland of Leiblein is large and convoluted, but, unlike other volutes, it surrounds the esophagus like a saddle and is so bound by muscles and connective tissue that in preserved specimens it is impossible to separate the regularly arranged loops (see fig. 7, Plate 82).

The present work has shown conclusively that the subfamilies, at least those recognized here, are natural groups established on a variety of characters. However, from an evolutionary point of view little can be said at this time. Though there is a good fossil record, it is now certain that similarity of shell characters does not indicate true relationships. As indicated by Woodward, it is possible that the nervous system may prove useful in this respect. Bouvier (1887) described and figured the nervous system of *Melo* [*Cymbium*] *neptuni* Gmelin showing that the supra-intestinal ganglion was widely separated from the right pleural ganglion. On the basis of this, Woodward, after describing the nervous system of *ancilla*, suggested that there appeared to be an increasing concentration of ganglia in the Volutidae and that *Melo* was probably a more primitive group. A dissection of *Cymbium papillatum* Schumacher shows it to be similar to that of *neptuni*, while in all other species dissected for this study the ganglia were highly concentrated. *Cymbium* also appears to differ from other volutes and perhaps to be less specialized in that the gland of Leiblein is not bound by connective tissues. The placement and appearance of the racemose salivary gland is more like that in *Buccinum*, and the tubular salivary gland is small. The radula of *Cymbium* is of the typically three-pronged type, which may indicate that the Zidoninae arose from a *Cymbium* stock. Undoubtedly when the detailed anatomy of many more species is known, this, in conjunction with the radula, will indicate true relationships and evolutionary trends.

Semi-diagrammatic sketches showing the arrangement of the organs of the anterior portion of the digestive tract of four of the subfamilies are shown on Plate 82.

Plate 82. Diagrammatic key to the major subfamilies and genera of the Volutidae in the Western Atlantic. The Odontocymbiolinae and Zidoninae have two equal lobes at the base of the siphons (Plate 83, figs. 1, 4-6); the Volutinae have two unequal lobes (Plate 83, figs. 2, 3) and the Scaphellinae have only the left lobe. The anatomical drawings of the anterior end of the digestive tract are stylized. The gland of Leiblein, except in the Scaphellinae, has been unwound and extended to the side. Normally it is in a tightly wound, irregular ball resting over the esophagus and nerve ring. The anterior end of the esophagus and buccal mass is drawn as if it were transparent in order to show the position of the salivary glands beneath.

Figs. 1-3. *Scaphella junonia* Shaw. Figs. 4-7. *Aurinia florida* Clench and Aguayo. Figs. 8-10. *Aurinia georgiana* Clench. Figs. 11-13. *Volutifusus torrei* Pilsbry. Figs. 14-16. *Voluta ebraea* Linné. Figs. 17-18. *Voluta musica* Linné. Fig. 19. *Voluta virescens* Solander. Figs. 20-22. *Adelomelon* (*Pachycymbiola*) *brasiliانا* Lamark. Figs. 23-26. *Adelomelon* (*Adelomelon*) *ancilla* Solander. Figs. 27-29. *Adelomelon* (*Adelomelon*) *beckii* Broderip. Figs. 30-31. *Zidona dufresnei* Donovan. Figs. 32-33. *Odontocymbiola magellanica* Gmelin. Figs. 34-36. *Odontocymbiola americana* Reeve.

Letters on anatomical drawings: A—Stomach opened to show internal ridges. B—Gland of Leiblein. C—Tubular salivary gland. D—Racemose salivary gland. E—Mouth. F—Gland of Leiblein.

The subfamily Calliotectinae is not included, as there is only one species in the Western Atlantic and nothing is known of its soft anatomy.

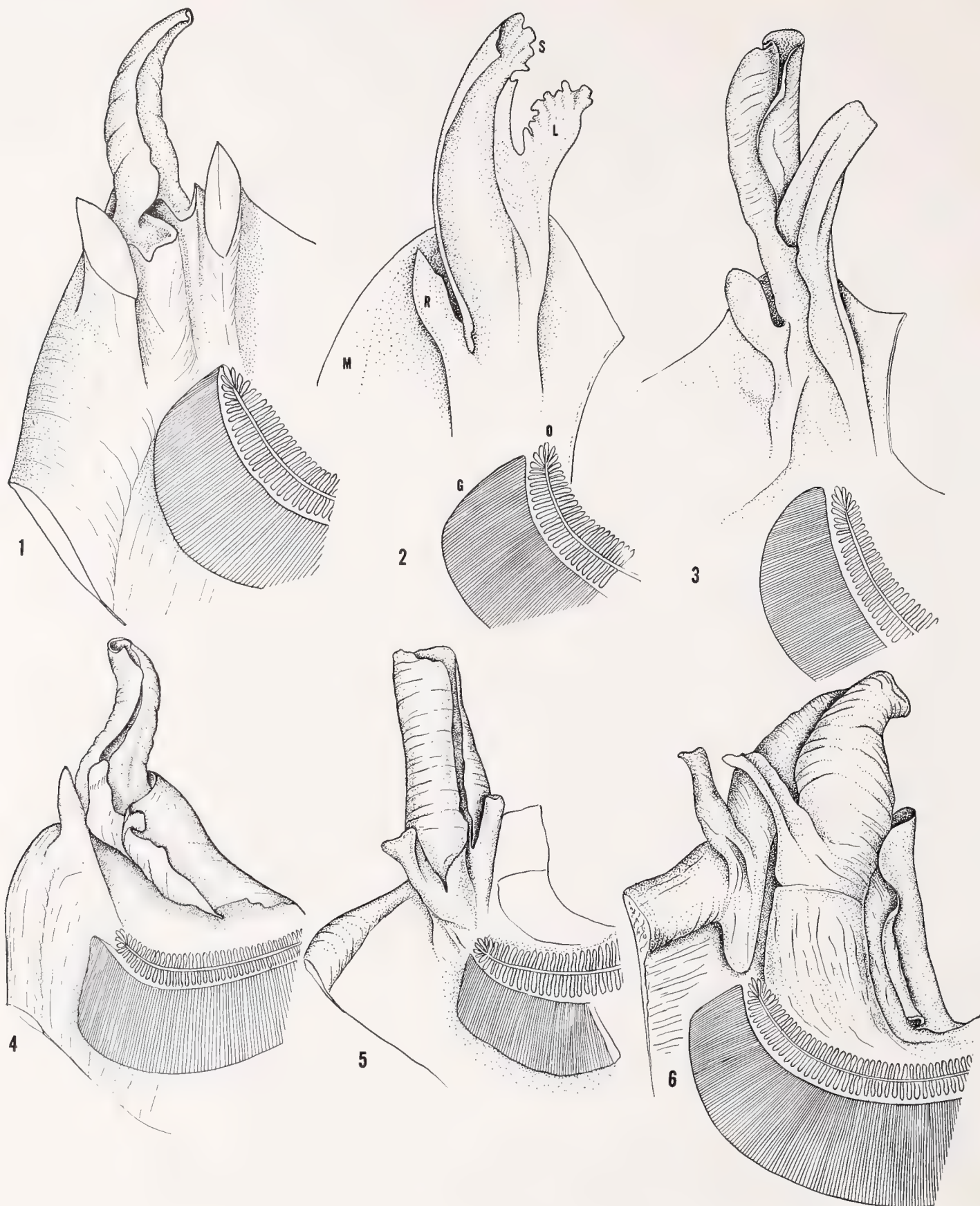


Plate 83. Ventral view of the siphons to show the relationship of the basal lobes, the gill and osphradium. Fig. 1. *Adelomelon riosi* Clench and Turner with short wedge-shaped lobes and thickened mantle margin. Fig. 2. *Voluta ebraea* Linné. Fig. 3. *Voluta musica* Linné. Fig. 4. *Adelomelon ancilla* Solander. Fig. 5. *Zidona dufresnei* Donovan. Fig. 6. *Odontocymbiola magellanica* Gmelin.

S—Siphon. L—Left lobe of siphon. R—Right lobe of siphon. M—Mantle. G—Gill. O—Osphradium.

All drawings made from preserved specimens.

Family VOLUTIDAE *Fleming* 1822

Shells extremely variable in shape and size, the largest species about 45 cm. (18 inches) in length. Most species have columellar plicae. The siphonal canal is well defined, usually forms a notch and succeeding growth stages often form a fasciole. The lip is usually simple and seldom reflected. Operculum, when present, small and unguiculate.

The foot is broad; the head small, flat and wide; the tentacles flat and triangular with eyes when present near their base. The siphonal tube is large with one or two lobes at the base; the mantle is variable: in some forms it may envelop the shell, while in others it extends only slightly beyond the aperture.

The Volutidae are rachiglossate, having the proboscises introvert, paired pre-neural salivary glands, a concentrated nervous system and a large gland of Leiblein. The radula is uniserial, except in two small subfamilies which may have small lateral teeth.

Subfamily VOLUTINAE *Swainson* 1840

The subfamily Volutinae is characterized by having an operculum, unequal lobes on the base of the siphons, broad multicuspid radular teeth, and the tubular salivary gland loosely associated with the racemose salivary gland.

So far as known this subfamily is restricted to the tropical Western Atlantic.

Genus *Voluta* *Linné*

Voluta Linné 1758, *Systema Naturae*, ed. 10, p. 729.

Plejona Röding 1798, *Museum Boltenianum*, p. 59 (type species, *V. ebraea* Linné, subsequent designation, Dall 1889).

Volutarius Duméril 1806, *Zoologie Analytique*, p. 166 [no species given].

Harpula Swainson 1831, *Zool. Illustrations* (2) 2: 77, pl. 77 (type species, *Voluta hebraea* Lam., original designation).

Musica Gray 1847, *Proc. Zool. Soc. London*, p. 141 (type species, *Voluta musica* Linné, monotypic).

Chlorosina Gray [in] H. and A. Adams 1858, *The Genera of Recent Mollusca* 2: 617 (type species, *Voluta polyzonalis* Gray (= *V. virescens* Solander), monotypic).

Volutolyria Crosse 1877, *Jour. de Conchy.* 25: 99 (type species, *Voluta musica* Linné, original designation); Fischer 1884, *Man. de Conchy.* Paris, p. 609.

Type species, *Voluta musica* Linné, subsequent designation, D. de Montfort, 1810.

The genus *Voluta*, as now restricted, consists of three species: *musica*, *ebraea* and *virescens*.

The shells are solid, nodulose and highly ornamented with a complex color pattern. The radula is uniserial, consisting of a series of rachidian teeth which are multicuspid, the two outer cusps being the longest (Plate 85). However, the central cusps vary in number in different radulae of any one species, even in a single radular ribbon. Operculum present. Siphonal lobes unequal.

Dall (1889, p. 146) selected *Voluta hebraea* Linné (= *ebraea*) to be the type species of *Plejona*. Much later (1906, p. 143) he attempted to retain *Plejona* and reselected *Conus* (= *Voluta*) *spinosa* Linné as its type. This last selection was invalid: first, because he had previously selected *V. ebraea* to be the type, and second, because *Voluta spinosa* Linné was not included in the list of species given by Röding under his genus *Plejona*. *Voluta ebraea* Linné is closely related to *Voluta musica* Linné.

Heilprin (1887) has described a *Voluta musicina* from Tampa Silex beds (Oligocene), Ballast Point, Tampa, Florida, which may well be the ancestral form of the *Voluta musica* complex.

Fischer (1884, p. 609) indicated that *Voluta musicalis* Lamarck (non Müller 1766) of the Eocene of the Paris Basin is a member of *Voluta* s.s. Lamarck's figures (1805, Ann. Mus. d'Hist. Nat. 6: pl. 43, fig. 7a-b) differ quite sharply from both *V. musica* and *V. ebraea* by being very much smaller and having only three plicae while *musica* and *ebraea* have five or more.

Voluta musica Linné

Plates 80, 82, 83, 84, 85

Voluta musica Linné 1758, Systema Naturae, ed. 10, p. 733 (O. Americae ad Jamaecam, Barbados). [We here limit the type figures to those of Gualtieri 1742, Index Test. Conch., pl. 28, fig. Z and here restrict the type locality to Barbados.]

Voluta thiarella Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 66 (? the Seas of America). [We here limit the type figure to Lamarck 1798, Tab. Encyclopédique et Méthodique 3: pl. 380, fig. 3.]

Voluta musica violacea Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 66.

Voluta thiarella nebulosa Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 66 [nomen nudum].

Voluta guinaica Lamarck 1811, Ann. Muséum d'Hist. Nat. Paris 17: 67 (probably on the coasts of Guinée). [Based upon Chemnitz 1785, Conchylien-Cabinet (1) 11: pl. 178, figs. 1717-1718.]

Voluta carneolata Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 67 (locality unknown). [Based upon Lamarck 1798, Tab. Encyclopédique et Méthodique 3: pl. 379, fig. 4.]

Voluta laevigata Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 67 (locality unknown). [Based upon Lamarck 1798, Tab. Encyclopédique et Méthodique 3: pl. 379, figs. 2a-b.]

Voluta fulva Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 68 (probably the Indian Ocean). [Based upon Lamarck 1798, Tab. Encyclopédique et Méthodique 3: pl. 382, figs. 3a-b.]

Voluta sulcata Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 68 (locality unknown). [Based upon Chemnitz 1788, Conchylien-Cabinet (1) 10: pl. 149, figs. 1403-1404.]

Voluta musica guineensis 'Chemnitz' Dillwyn 1817, Descriptive Catalogue of Recent Shells, London, p. 562 (no locality given).

Voluta plicata Dillwyn 1817, Descriptive Catalogue of Recent Shells, London, p. 563 (East Indian Seas).

Voluta polyzonata 'Lamarck' Kiener 1839, Icon. Coquilles Vivantes 3: 32, pl. 32, figs. 1-2 (Indian Ocean).

Voluta musica polypleura Crosse 1876, Jour. de Conchy. 24: 163, pl. 5, fig. 6 (locality unknown).

Voluta musica damula Dall 1907, Smithsonian Miscellaneous Collections 48: 347 (Curaçao). [Based upon Sowerby 1847, Thes. Conchyl. 1: pl. 49, fig. 42.]

Voluta musica typica 'Lamarck' Dall 1907. Smithsonian Miscellaneous Collections 48: 346 (Tobago, West Indies).

Voluta rugifera 'Lamarck' Dall 1907. Smithsonian Miscellaneous Collections 48: 347 [nomen nudum].

Voluta rugifera 'Lamarck' Salmon 1952. Jour. de Conchy. 92: 66, fig. 1 (des Indes). [Type in the Paris Museum.]

Description. Shell reaching 88 mm. (about $3\frac{1}{2}$ inches), imperforate, very solid, smooth, axially costate and knobbed. Color ivory to pale pink, overlaid with a complicated pattern of spiral lines and dots with axial threads of color lines between the spiral lines. Irregular lines of spiral dots appear above and below the thin spiral lines. On the inside of the outer lip there are several dark brown spots which are sometimes grouped in couples, in others, these spots occur singly. Spire moderately extended and produced at an angle of about 55° (males) and 70° (females). Aperture relatively wide and oblique. Outer lip thick and recurved. Parietal wall smooth, with a thin glaze and having several plicae, the lower 5 being fairly strong, the upper 2 to 6 being rather weak. Occasionally, small secondary plicae occur between the large lower 5 plicae. These plicae follow back along

the columella to the earliest whorls. Columella short and arched backwardly. Suture slightly impressed and irregular owing to the axial knobs. Sculpture consisting of large rounded knobs at the whorl shoulder. These are the end points of the axial ridges which become narrow and lower below and generally disappear at about the whorl periphery.

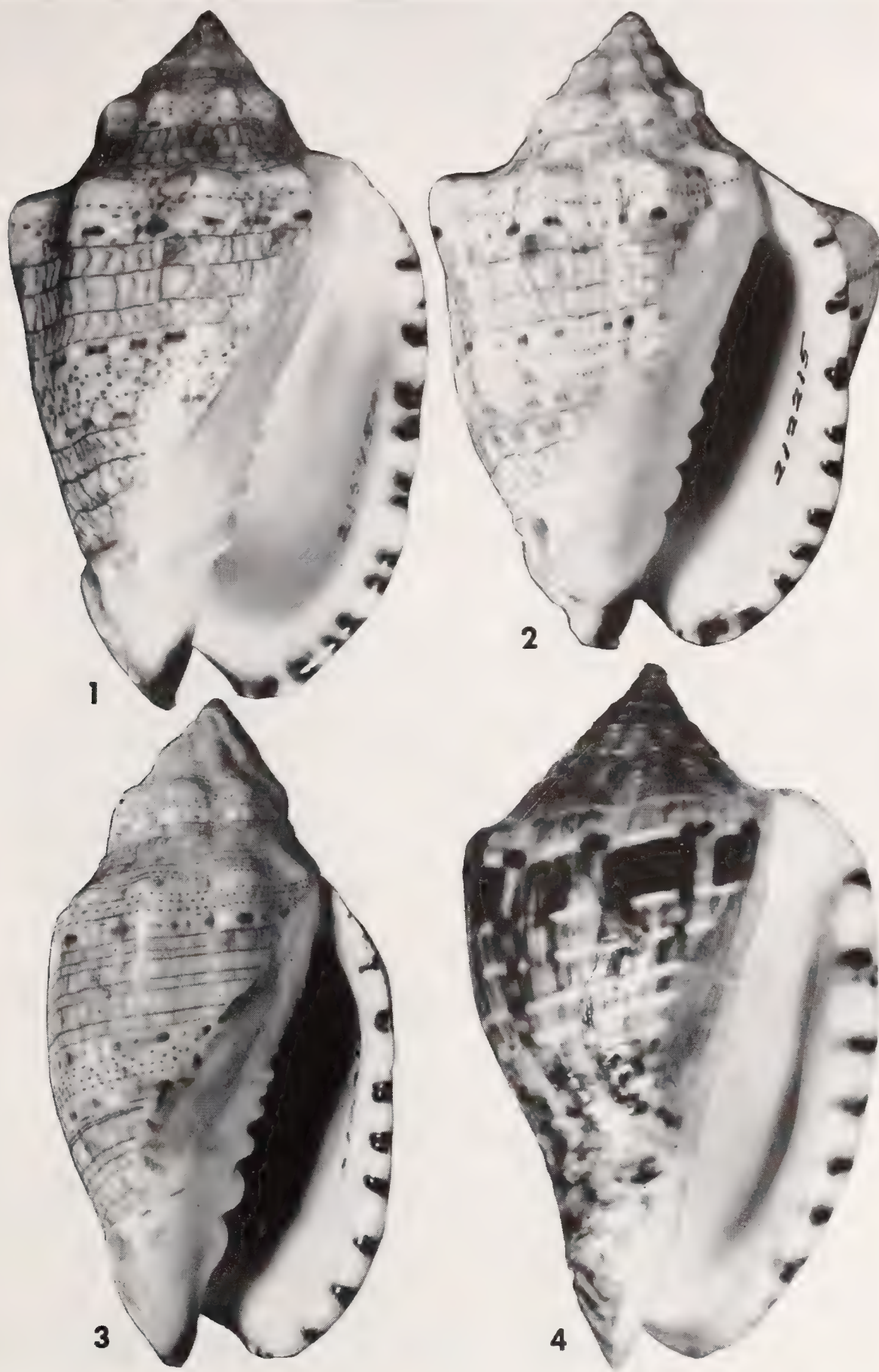


Plate 84. Figs. 1-3. *Voluta musica* Linné. Porlomar, Isla Margarita, Venezuela (about natural size). Fig. 4. *Voluta virescens* Solander. Venezuela (2x).

Protoconch smooth, generally a dark brown in color and consisting of two whorls. Operculum unguiculate, about one-fourth the length of the aperture, corneous with concentric lines of growth and a subterminal nucleus.

The radula is uniserial, composed entirely of rachidian teeth, rather wide and having two large marginal denticles and 7 to 12 much smaller central denticles.

Foot divided anteriorly, pale ivory with large, irregularly placed, somewhat diffused purple-brown pigment spots which are interspersed with numerous small red-brown speckles. Head and edge of mantle similarly colored. Eyes small, black and located at the base of the tentacles.

length	width	
88 mm.	46.5 mm.	Margarita Island, Venezuela
83	58	“ “ “
77.5	42.5	Grenada, Lesser Antilles
84.5	50	Barbados, Lesser Antilles
42	25	“ “ “
81	53	Curaçao, Netherlands, West Indies
42.5	24	“ “ “ “

Remarks. A specimen of this species from the collection of Linné is now in the Linnean Society of London. We seriously question whether Linné possessed a specimen in 1758 when the original description was published. The type figure is here selected to be that of Gualtieri 1742, pl. 28, fig. Z. Linné probably obtained his locality data from Martin Lister 1685–1697, Hist. Meth. Conch., where the words “Jamaica, Barbados” were printed on Pl. 805.

On Plate 85, figs. 1–2, the teeth illustrated were from a radula 3 mm. in length, from a specimen 61 mm. in length. In fig. 3 the tooth was from a radula 9 mm. in length, the specimen being 69 mm. in length. Both were females and both were adult specimens. It is quite possible that the small radula was newly regenerated, the animal having lost its original radula through some accident. This theory is supported by unpublished data (briefly summarized in Carriker 1961) regarding the experimental amputation and subse-

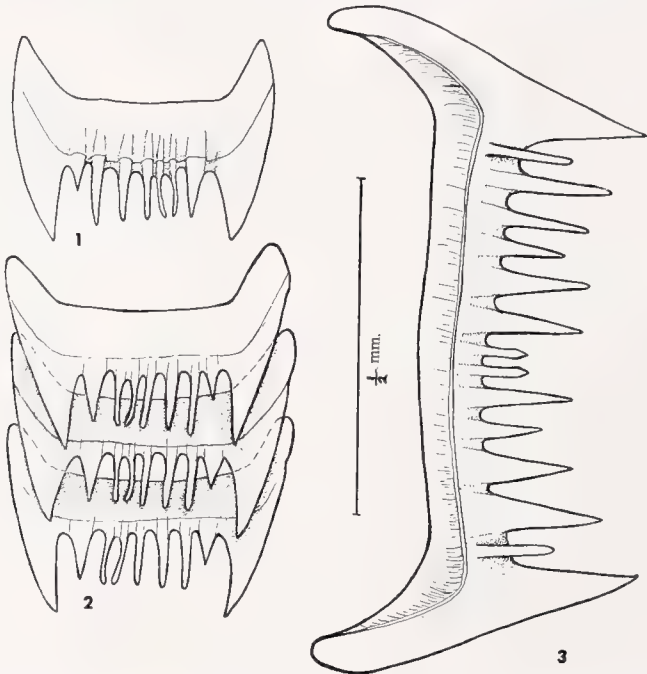


Plate 85. Radula of *Voluta musica* Linné. Bucco Reef, Tobago, Lesser Antilles. Length of radula 3 mm. Fig. 1. Back view of a single tooth. Fig. 2. Front view of three teeth in normal position. Fig. 3. A single tooth from a 9 mm. radula.

quent regeneration of the proboscis in *Urosalpinx* and *Eupleura*. Dr. Melbourne Carriker in a letter stated that the proboscises of numerous specimens were removed with iris scissors, and it took from 11 to 34 days to regenerate the proboscises sufficiently for the animals to begin feeding again.

Voluta musica is an exceedingly variable species in all of its shell morphology. The large number of names in the synonymy above are based upon these variations. Even specimens in unit populations exhibit differences in size, coloration, extent of the color pattern and in the size and number of the axial plicae. None of these variations appear to have any geographic significance. *V. musica* Linné differs from *V. ebraea* Linné by being smaller, having the shoulder knobs blunter and having a different color pattern. The largest specimen of *musica* we have seen reached 88 mm. while the largest specimen of *ebraea* measured 206 mm. in length. The operculum differs from that of *V. ebraea* by having the nucleus subterminal, the growth lines concentric and reaching from one margin to the other. In *V. ebraea* the nucleus is subcentral with the growth lines subcircular.

Sexual dimorphism is exhibited in the shells of this species: the heavy and strongly knobbed broad specimens being females; the more numerous and narrower specimens being males.

This appears to be a rather common species in the southern Lesser Antilles, but exceedingly rare in the northern portion of its range.

Dall (1907, p. 346) referred to and described *Voluta musica typica* Lamarek. Very probably Dall meant only the word "typical" in reference to the main species, as no such name was instituted by Lamarek. Nonetheless, this name appears as a validly introduced trinomial and has been used by subsequent students.

No species of *Voluta* s.s. occurs on the west coast of Africa. Even as late as 1907 Dall gave several African localities for *V. ebraea* Linné and *V. virescens* Solander. Early "records" for West Africa have been copied repeatedly from one monograph to another. Nicklès (1950) in his study of West African marine mollusks does not mention the genus.

Range. From Hispaniola south through the Lesser Antilles and south to British Guiana.

Warmke and Abbott (1961, p. 126) report this species from near Guanica, Puerto Rico.

Specimens examined. HISPANIOLA: Monte Cristi, Dominican Republic (MCZ). VIRGIN ISLANDS: St. Thomas (MCZ). LESSER ANTILLES: Dominica (USNM); Port Castries and Pigeon Island, St. Lucia (both MCZ); St. Vincent (USNM); Maxwell's Coast and off Pelican Id., Barbados (both USNM); St. Georges, Granada; Carriacou Id., Grenadines; Speyside and Buccoo Reef, Tobago (all MCZ); Chaguaramas and Magueripe Bays, Trinidad (both H. G. Kugler); Salybia Bay and Toco, Trinidad (both MCZ). CARIBBEAN ISLANDS: Williamstadt (R. Atmus) and Santa Ana Harbor (ANSP), both Curaçao; Bonaire; Aruba and Isla Orchilla (all USNM); Margarita Id. (MCZ; USNM); Los Testigos (ANSP). VENEZUELA: Tucacas Bay, Est. Falcon (H. G. Kugler); Porto Cabello (ANSP); La Guaira (USNM). BRITISH GUIANA: Corentyne River (MCZ).

***Voluta ebraea* Linné**

Plate 82, 83, 86, 87

Voluta ebraea Linné 1758, *Systema Naturae*, ed. 10, p. 733 (O. Asiatico). [We here limit the type figure to F. Buonanni 1684, *Recreatio Mentis et Oculi*, p. 154, fig. 293.]

Voluta hebraea Gmelin 1791, Systema Naturae, ed. 13, p. 3461 (India and Jamaica).

Voluta chlorosina Lamarek 1811, Ann. Muséum d'Hist. Nat., Paris 17: 66 (locality unknown); Salmon 1952, Jour. de Conchy. 92: 67, fig. 2.

Voluta turbinata Kiener 1839, Icon. Coquilles Vivantes 3: 19, pl. 26, fig. 2 (Indian Ocean).

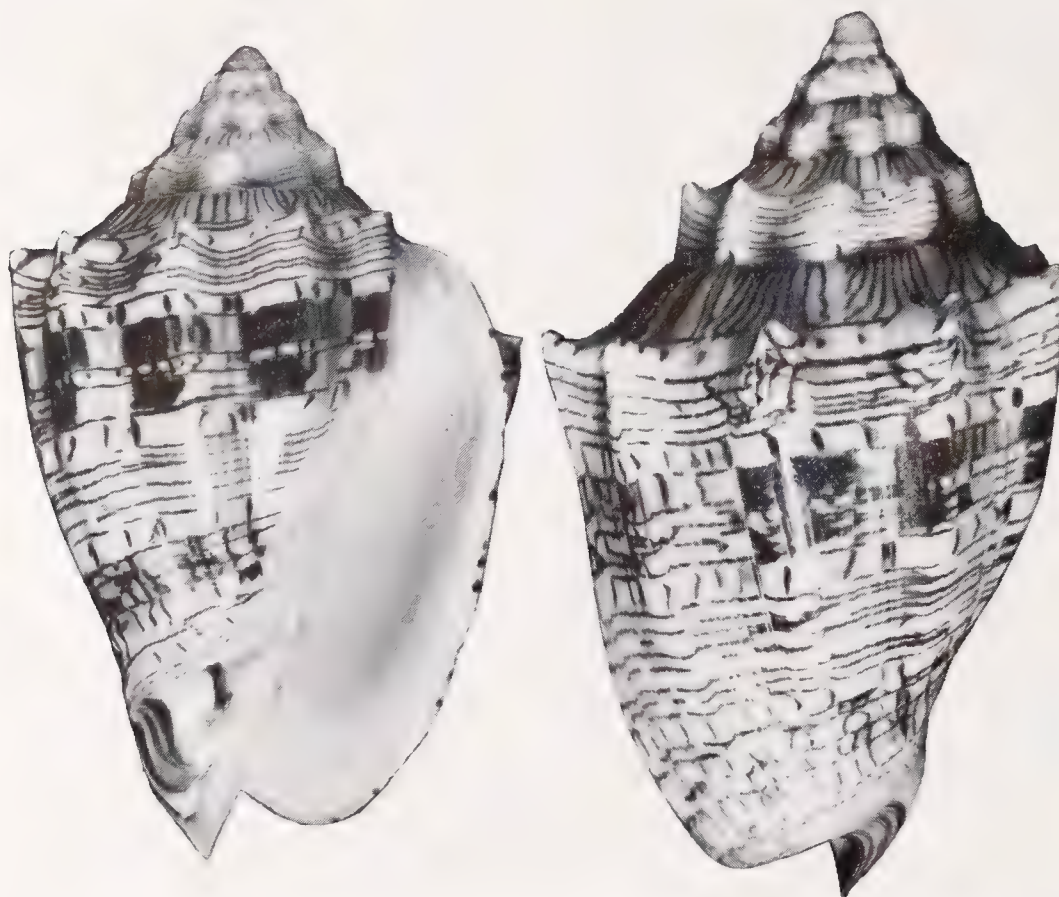


Plate 86. *Voluta ebraea* Linné. (Left) Paripueira, Alagoas, Brasil (1.14x). (Right) Alagoas, Brasil (about natural size).

Description. Shell reaching 90 mm. ($3\frac{1}{2}$ inches) in length, imperforate and solid. Color complex and variable, consisting of numerous, spiral lines of reddish brown and usually two broad, irregular, spiral bands of the same color. The ground color ranges from ivory to a dark brown, and occasional specimens lack spiral lines. On the whorl shoulder there are numerous, axial, thread-like lines of brown. Whorls 7 and slightly convex. Spire moderately extended and produced at an angle of about 60° (males) and 75° (females). Aperture long and narrow. Outer lip thick and very slightly reflected. Parietal wall glazed and having 5 to 6 strong plicae below and 4 to 5 weak to very weak plicae above. Columella short and recurved to form a short siphonal canal. Suture irregular and slightly indented. Sculpture consisting of 9 to 11 large, short shoulder spines on each whorl which point upwards and are sharp. The bases of these spines form rounded ridges which flatten out and disappear at the whorl periphery. Protoconch smooth, rather large and having 2 whorls. Operculum unguiculate, only one-fourth as long as the aperture, with a subcentral nucleus and sculptured with numerous, concentric growth lines.

Radula similar, but larger than that of *V. musica* Linné. As in *musica*, the broad and heavily knobbed specimens are females; the more slender ones are males.

The foot and mantle of the animal are pale ivory with numerous, narrow, dark red, thread-like lines which form an irregular, net-like pattern. In addition, there are a few small spots of the same red color which appear along the sides of the foot. The mantle is pale ivory except for a narrow strip of red lines on the inner surface just anterior to the

siphon; this continues over the siphon and around the edge against the columella. Foot very large with a large fleshy lobe anteriorly. No eyes evident.

length	width	
206 mm.	110 mm.	Barra de Maxaranguapé, north of Natal, Brasil
175	111	9 miles off Muriú [15 miles north of Natal], Brasil
170	112	off Recife, Brasil
119	72	[Brasil]
98	60	São Luiz do Maranhão, Brasil
83	48	Alagoas, Brasil

Remarks. According to Dodge (1955, p. 126), Linné did not have a specimen of this species, at least at the time the original description was published. As stated in the synonymy above, we select Buonanni, fig. 293, to be the type figure. Linné's reference to the figures in Gualtieri 1742 and Rumphius 1741 are not *ebraea* but *vespertilio* Linné, a species common in Indonesia and the Philippines.

Voluta ebraea is probably limited to the coast of Brasil. Many of the early references were to the Indian Ocean, West Africa, and Jamaica, but these were only guesses. It must be remembered, however, that data of this sort had only casual interest during the early days of descriptive zoology.

See *Remarks* under *V. musica* Linné.

Range. Probably only the northern coast of Brasil.

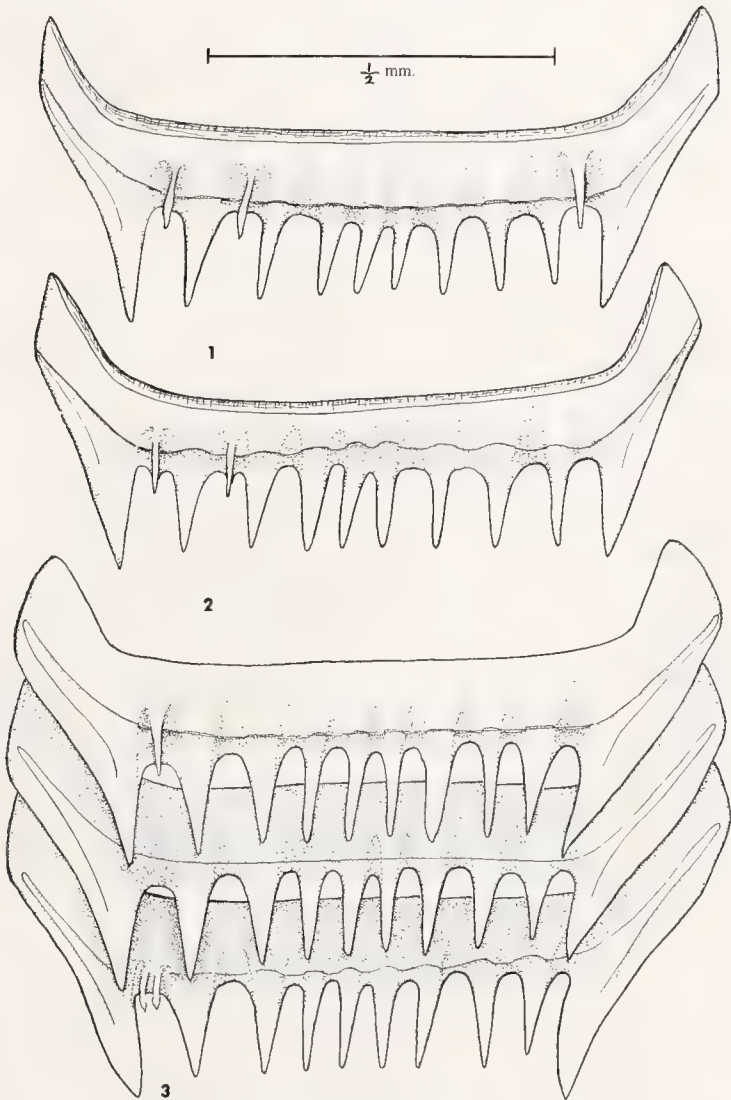


Plate 87. *Voluta ebraea* Linné. São Luiz do Maranhão, Brasil. Figs. 1 and 2. Single teeth showing the variation in the number of small, secondary denticles. Fig. 3. Three teeth in normal position.

Specimens examined. BRASIL: Barra de Maxaranguapé, north of Natal, Est. Rio Grande do Norte and 9 miles off Muriú (15 miles N of Natal), Est. Rio Grande do Norte, in 15 fathoms, coral, rocks and sand bottom (both B. Tursch); São Luiz do Maranhão, Est. Maranhão (Thayer Exp., MCZ); 7 miles S of and Suape village, 21 miles S of Recife, Est. Pernambuco (both MCZ); Alagoas, Est. Pernambuco (Ruth Craine; P. Cardoso; ANSP); near Todos Santos Bay, Est. Bahia (D. L. Bryant).

Voluta ? virescens Solander

Plates 82, 84

Voluta virescens Solander 1786, Catalogue of the Portland Museum, London, p. 26, no. 610 (Guinea). [Based upon Martini 1777, Conchylien-Cabinet (1) 3: 97, figs. 932-933. [Type locality, here selected, Cartagena, Colombia.]

Voluta polyzonalis Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 68 (Indian Ocean). [Based upon Lamarck 1798, Tab. Encyclopédique et Méthodique 3: pl. 379, figs. 1a-b.]

Voluta fulva Lamarck 1811, Ann. Muséum d'Hist. Nat., Paris 17: 68 (probably the Indian Ocean). [Based upon Lamarck 1798, Tab. Encyclopédique et Méthodique 3: pl. 382, figs. 3a-b.]

Voluta pusio Swainson 1823, Philosophical Magazine 61: 378 (no locality given); Swainson 1823, Zool. Illustrations 3: pl. 181.

Description. Shell relatively small, reaching about 53 mm. ($2\frac{1}{8}$ inches) in length, solid, imperforate and sculptured. Color white to ivory with spiral bands of grayish brown. In addition, there may be a series of brownish dots in spiral arrangement — whitish in zones separating the brownish bands. On the outer lip there may be 6 to 9 short horizontal bars of brown. Whorls 7 and slightly convex. Spire depressed and produced at an angle of about 80° . Aperture long and narrow. Outer lip thickened and reflected. Parietal wall glazed and with 9 to 12 irregular plicae. Columella short and recurved dorsally to form one side of the siphonal canal. Suture slightly indented. Sculpture consisting of 8 to 10 rounded knobs at the whorl shoulder. The bases of the knobs form rounded ridges which extend down the whorl and flatten out at about the whorl periphery. In addition, there are numerous axial threads which are crossed by fine spiral grooves. Protoconch of $1\frac{1}{2}$ whorls and smooth. Operculum and radula unknown.

length	width	
53 mm.	33 mm.	Cartagena, Colombia
47	27	Cartagena, Colombia
41	23	Puerto Escondito, Colombia

Remarks. *Voluta virescens* Solander is a rare species judging from the few specimens we have seen. Dall's record (1907, p. 349) of this species from 'Mesquital', Texas, is certainly open to question. West African records are in error.

Voluta virescens Solander differs from both *V. musica* and *V. ebraea* by being much smaller and in having a very different color pattern. The soft anatomy of this species has not been examined so that its generic position is still uncertain.

Range. Nicaragua and south to Colombia.

Specimens examined. NICARAGUA: Wounta Haulover (USNM). PANAMA: Colón (ANSP; USNM). COLOMBIA: SW Bolivar coast, N of Puerto Escondido; S Bolivar coast, near Tolú (both R. W. Barker); Crespo Beach, Cartagena (R. Atmus; USNM); Savanilla; near Santa Marta (both USNM).

Subfamily ZIDONINAE *H. and A. Adams*

Zidoninae H. and A. Adams 1853, The Genera of Recent Mollusca, London **1**: 161.

Alcithoinae Pilsbry and Olsson 1954, Bull. American Paleontology **35**: 287.

This subfamily was introduced by H. and A. Adams in 1853 to include the single genus *Zidona*. Pilsbry and Olsson in 1954 created the subfamily Alcithoinae which included *Zidona* along with several other genera.

The subfamily is characterized by having the radula uniserial, composed of rachidian teeth only: each tooth with three, pointed denticles in one plane: having two equal lobes at the base of the siphon; lacking an operculum and having the tubular salivary gland loosely wound around the moderately compact racemose salivary gland (see Plate 82).

Genus *Zidona* *H. and A. Adams*

Volutella d'Orbigny 1841, Voyage dans l'Amérique Méridionale **5**: 422 (type species, *Voluta angulata* Swainson, monotypic); non *Volutella* Perry 1810; Swainson 1830.

Zidona H. and A. Adams 1853, The Genera of Recent Mollusca **1**: 161 (type species, *Z. angulata* 'Solander' H. and A. Adams, non Solander 1786, monotypic).

The crediting of *Z. angulata*, the type species of *Zidona*, to Solander rather than Swainson, was a simple case of *lapsus* on the part of H. and A. Adams, for their figures and description are of *angulata* Swainson (= *dufresnei* Don.) and not *angulata* Solander (= *Xancus angulatus* Sol.).

Only a single species is known in this genus; therefore, the specific characters will hold for the genus as well. The radula is uniserial, rachidian teeth only, each tooth with three pointed denticles in one plane. Mantle extended over most of the outer surface of the shell and producing a spur on the apex (Plate 89).

Zidona dufresnei Donovan

Plates 82, 83, 88, 89, 90, 91

Voluta angulata Swainson 1821, Exotic Conchology, London (1) **1**: [p. 6], pls. 3-4 (Pacific Ocean). [Syntype, British Museum, ex Mawe collection]; ibid. 1841, edited by S. Hanley, p. 17, pls. 3-4 (Southern Pacific Ocean); non *Voluta angulata* Solander 1786, Catalogue of the Portland Museum, p. 76 (= *Xancus angulata* Solander).

Voluta dufresnei Donovan 1823, Naturalists' Repository **2**: pl. 61¹ [Argentina.] [Type specimen probably lost.]

Voluta nasica Schubert and Wagner 1829, Conchylien-Cabinet (1) **12**: 10, pl. 217, figs. 3031-3032 (locality unknown). [Holotype of this species may be in the Polytechnic Institute in München, Germany.]

Volutella angulata Swainson. d'Orbigny 1841, Voyage dans l'Amérique Méridionale, Paris **5**: 423, pl. 60, figs. 1-3 (Río de La Plata to San Blas, Patagonia).

Zidona angulata 'Solander' H. and A. Adams 1853, The Genera of Recent Mollusca, London **1**: 161 (South America); non *Voluta angulata* Solander 1786.

Voluta angulata Swainson. Lahille 1895, Revista del Museo de La Plata **6**: 307, pl. 2, figs. 69-78; pl. 6 and pl. 7. Lahille has described the following forms: *luteola*, p. 309; *mixta*, p. 309 (non Galeotti 1837); *similis*, p. 310; *distincta*, p. 310; *ventricosa*, p. 310 (non Dillwyn 1817); *affinis*, p. 311 (non Brocchi 1814).

Description. Shell rather large, reaching 190 mm. (7½ inches) in length, imperforate, smooth, glazed and with a broad whorl shoulder. Color yellowish to orange, the more intense coloration exhibited on the ventral area. In addition, there are numerous, irregu-

¹The type "locality" as given by E. Donovan: "Found by Capt. Campbell on the east coast of the Cape of Good Hope, but is better known as a native of California in South America."

lar, axial, zig-zag lines of a reddish brown coloration. Whorls 4 to 5, shouldered and nearly flat sided. Spire extended, acute and produced at an angle of about 50° .¹ Aperture long, nearly equal in length to the body whorl and subquadrate in outline. Outer lip thin. Parietal area heavily glazed. Columellar area with 3 or 4 generally unequal plicae. Suture slightly indented. Sculpture consisting of very fine and irregular growth lines. Protoconch of two small whorls, the first papilliform and covered by a "spur," a narrow prolongation which may be straight or curved and may extend as much as 20 mm. in length beyond the end of and following the shell axis.

The radula is uniserial, with rachidian teeth only, each having three, sharp, subequal, pointed denticles in the same plane.



Plate 88. *Zidona dufresnei* Donovan, after Donovan, Naturalists Repository 1823, Vol. 2, pl. 61 (natural size).

¹ Not including the body whorl shoulder.

length	width	
207 mm.	80 mm.	off Cabo Búzios, Brasil
190	73	Puerto Quequén, Argentina
148	71	Patagonia, Argentina
117	60	off Rio de Janeiro, Brasil
128	55	Punta del Este, Uruguay
130	52	Syntype of <i>V. angulata</i> Swainson



Plate 89. *Zidona dufresnei* Donovan. From Puerto Quequén, Argentina (about natural size).

This species is quite variable in the ratio between the width and length. We give below the measurements of two populations.

17 miles off Ilha Grande, Est. Rio de Janeiro, Brasil

length	width	ratio of width to length
191 mm.	78 mm.	2.45 largest specimen
102	45	2.26 smallest specimen
153	64	2.39 average of 10 specimens
Extreme ratios were 2.67 and 2.26		

4 miles off Cabo Búzios, Est. Rio de Janeiro, Brasil

length	width	ratio of width to length
207 mm.	80 mm.	2.59 largest specimen
78	37	2.11 smallest specimen
134	56	2.57 average of 18 specimens
Extreme ratios were 2.70 and 1.91		

Remarks. Neither Dall 1907 or Carcelles 1944 have accepted the numerous variants to which Lahille attached names.

This species ranges in shape and size from rather short and broad specimens to those which are a little narrower but proportionately far more attenuated.

The animal possesses a rather broad foot and a mantle which can almost completely



Plate 90. *Zidona dufrénei* Donovan. After A. d'Orbigny 1847, Voyage dans l'Amérique Méridionale, pl. 60 (about $\frac{2}{3}x$).

cover the outer surface of the shell. It is at this time when the mantle is fully extended that the spur is produced. It increases the length of the shell, being sometimes up to one inch long.

According to B. Tursch (in letter) the body of the animal is mottled with dark green on a rich cream colored background.

Range. Cabo Frio, Est. Rio de Janeiro, Brasil, and south to the Golfo San Matías, Argentina.

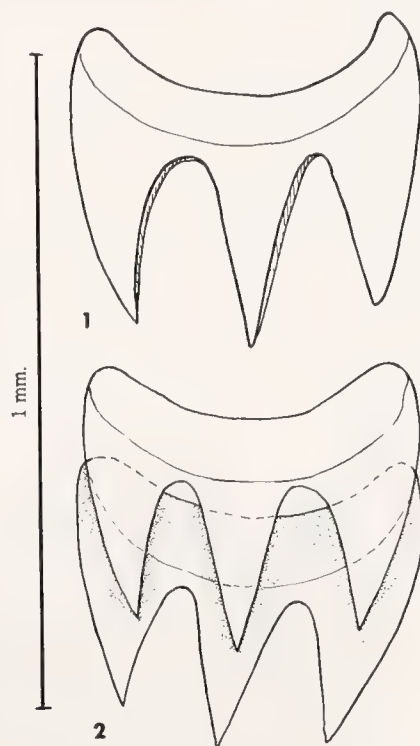


Plate 91. *Zidona dufresnei* Donovan. Off Isla Lobos, Uruguay. Length of radula 6 mm. Fig. 1. Single tooth. Fig. 2. Two teeth in normal position.

Specimens examined. BRASIL: 15 miles off Macaé, Est. Rio de Janeiro, in 32 fathoms, sand and mud bottom; 4 miles off Cabo Búzios, Est. Rio de Janeiro, in 25 fathoms, sand and mud bottom (both B. Tursch); Cabo Frio, Est. Rio de Janeiro (M. J. de Oliveira); Rio de Janeiro (MCZ); 10 miles off Ilha Rasa, Est. Rio de Janeiro, in 35 fathoms, mud bottom; 17 miles off Ilha Grande, Est. Rio de Janeiro, in 35 fathoms, mud bottom (both B. Tursch); Praia de Imbituba, 30 km. N of Laguna, Est. Santa Catarina (M. J. de Oliveira); Sarita and Albardão, both Est. Rio Grande do Sul (ANSP). URUGUAY: Cabo Castillo (=Cabo Polonio) (USNM); Cabo Santa María (MCZ; USNM); Punta del Este, Maldonado (E. Duarte; USNM); Piriapolis (USNM). ARGENTINA: Puerto Quequén, Prov. Buenos Aires (MCZ; ANSP; A. Carcelles); Monte Hermoso, Buenos Aires (USNM); San Antonio, Golfo San Matias, Prov. Rio Negro (MCZ).

Genus *Adelomelon* Dall

Scaphella and *Cymbiola* of authors, not of Swainson 1832.

Adelomelon Dall 1906, *Nautilus* **19**: 143, non Pilsbry and Olsson 1954.

Janeithoe Pilsbry and Olsson 1954, *Bull. American Paleontology* **35**: (152): 25 (type species, *Voluta beckii* Broderip).

Type species, *Voluta ancilla* Solander, original designation.

Shells medium to large in size, elongate and with moderate to strongly convex whorls, which may be smooth or with low ridges or knobs at the whorl shoulder; sculpture consisting of fine growth lines and often with very fine spiral threads.

Radula uniserial, each tooth with three subequal and pointed denticles in one plane. Operculum lacking. Mantle not extending over the shell. Periostracum when present rather thin.

Subgenus *Adelomelon* Dall

Shells smooth or with knobs at the whorl shoulder, usually attenuated and with very moderately convex whorls. Periostracum thin and deciduous.

Adelomelon (Adelomelon) ancilla Solander

Plates 82, 83, 92, 93, 94

Voluta ancilla Solander 1786, Catalogue of the Portland Museum, p. 137, no. 3061 (Straits of Magellan). [Based upon Davila 1767, Catalogue des Curiosités de la Nature et de l'Art 1: 140, no. 181, pl. 8, fig. S.] [Type lost.]

Voluta spectabilis Gmelin 1791, Systema Naturae, ed. 13, p. 3468 (in freto magellanico). [Based upon Davila 1767, as given above.]

Voluta magellanica Lamarek 1811, Annales du Mus. d'Hist. Nat., Paris 17: 69. [Based on Tab. Encyclopédique et Méthodique 1798, 3: pl. 385, figs. 1a-b.] (Straits of Magellan); non *V. magellanica* Gmelin 1791.

Voluta gracilis Wood 1825, Index Testaceologicus, suppl. p. 59, pl. 3, fig. 2 (no locality given). [Type lost.]

Voluta magellanica 'Gmelin' Gould 1852, United States Exploring Expedition 12: 278, pl. 20, fig. 357 (Burnt Id., Orange Harbour [Straits of Magellan]); non *magellanica* Gmelin.

Scaphella (Voluta) arnheimi Rivers 1891, Proc. California Acad. Sci. (2) 3: 107 (Monterey Bay, California); Rivers 1892, Nautilus 5: 111 [Locality in error.]

Voluta braccata Mabilie and Rochebrune 1891, [in] Mission Scientifique de Cap Horn 6: H48 (Baie Orange [Orange Bay, Tierra del Fuego, Chile]). [Syntypes, Paris Museum.]

Voluta ancilla Solander. Lahille 1895, Revista del Museo de la Plata 6: 313-316, pl. 1, figs. 9-10; pl. 2, figs. 61, 63, 66; pl. 8; pl. 9 (Argentina). Lahille has introduced the following named forms: *ponderosa*, p. 315; *elongata*, p. 315; *inflata*, p. 315; *expansa* p. 315; *abbreviata*, p. 316.

Voluta martensi Strebel 1906, Zoologische Jahrbücher 24: 124, pl. 9, figs. 34-35; 42-44; pl. 10, figs. 56-56a (Straits of Magellan; Peru).

Voluta bracteata 'Mabilie and Rochebrune' Strebel 1906, Zoologische Jahrbücher 24: 92 (error for *braccata* M. and R.).

Pachycymbiola magellanica 'Sowerby' Pilsbry and Olsson 1954, Bull. American Paleontology 35: 306, pl. 28, fig. 3; non *Voluta magellanica* Gmelin 1791.

Adelomelon ancilla [sic] (Solander). Barattini and Ureta 1960, La Fauna de las Costas Uruguayas del Este, Montevideo, p. 124, pl. 34.

Description. Shell large, reaching 186 mm. ($7\frac{1}{4}$ inches) in length, attenuated, imperforate and smooth. Color dark brown when covered with periostracum. Devoid of periostracum, the shell is dull, a pale, pinkish white, with the interior of the aperture a pale orange. Whorls 7 and convex. Spire extended and forming an angle of about 45° . Aperture semi-circular. Outer lip thin and simple. Parietal wall glazed, sharply margined, and having 2 to 3 well defined plicae. Columella nearly straight. Sutures well indented. Sculpture consisting of exceedingly fine growth lines. Protoconch relatively small. Siphonal canal rather broad and shallow. Periostracum deciduous, but dark brown when present and relatively thick. Radula uniserial, rachidian teeth only with three subequal, pointed denticles in one plane.

length	width	
186 mm.	66 mm.	off Mar del Plata, Argentina
174	86	off Mar del Plata, Argentina
172	68	Puerto Hambre, Chile
137	55	Isla de Lobos, Uruguay
180	67	Syntype of <i>V. bricata</i> M. and R.
160	65	Syntype of <i>V. bricata</i> M. and R.



Plate 92. *Adelomelon ancilla* Solander. Isla de Lobos, Maldonado, Uruguay (about natural size).

Remarks. There has been considerable confusion regarding *Adelomelon ancilla* (Solander) and *Odontocymbiola magellanica* (Gmelin). The confusion was initiated when Lamarck described his *Voluta magellanica* 1811 (= *ancilla* Solander), non *V. magellanica* Gmelin 1791. This confusion persisted as late as 1954 when Pilsbry and Olsson used the name of *magellanica* "Sowerby" (based upon Lamarck's name, not that of Gmelin). This was most unfortunate as they figured the very remarkable radula of *magellanica* Gmelin, but called it *ancilla* Solander. Very fortunately we had alcoholic material of both species col-

lected by the *Hassler* Voyage in 1872. The shells of these two species are quite similar. *A. ancilla* differs from *O. magellanica* by being narrower, having a more acute spire, and in having fewer zig-zag color markings. The young of *A. ancilla* Solander are extended and have a pointed calcarella.

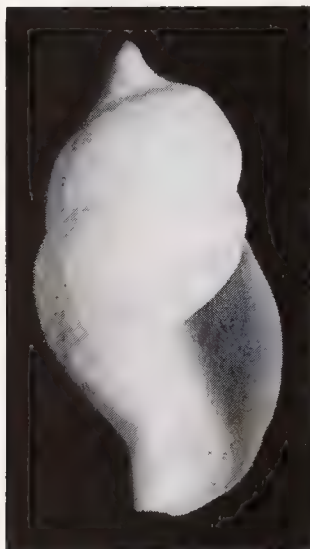


Plate 93. *Adelomelon ancilla* Solander. Young specimen, about 60 miles east of Punta Rasa, Río Negro, Argentina, *Hassler* Voyage 1872 (3.57x).

Range. Southern Brasil and south to the Straits of Magellan. It is reported by Melvill and Standen (1907) from the Falkland Islands.

Specimens examined. BRASIL: off Chuy, Rio Grande do Sul, in 5 fathoms (ANSP). URUGUAY: off Cabo Santa Maria (E. Rios; C. Weaver); Isla de Lobos, Maldonado (E. Duarte); off Punta del Este, Maldonado (USNM). ARGENTINA: off Río de la Plata ($37^{\circ}42' S$; $56^{\circ}20' W$) in 44 fathoms (*Hassler* Voyage, MCZ); Cabo de San Antonio, in 30 fathoms (ANSP); about 120 miles off Mar del Plata, Prov. Buenos Aires, in 99 fathoms (C. Weaver; E. Rios); *Albatross*, station 2767, about 160 miles SW of Mar del Plata ($40^{\circ}03' S$; $58^{\circ}56' W$) in 64 fathoms (USNM); off Bahía Blanca, in 55 fathoms (ANSP); about 60 miles E of Punta Rasa, Río Negro ($40^{\circ}22' S$; $60^{\circ}35' W$) in 30 fathoms (*Hassler* Voyage, MCZ); Cabo Buen Tiempo (ANSP). CHILE: Cabeza del Mar (ANSP); *Albatross*, station 2778, Straits of Magellan, about 17 miles NE of Punta Arenas ($53^{\circ}01' S$; $70^{\circ}42' W$) in 61 fathoms (USNM); Puerto Hambre, Straits of Magellan ($53^{\circ}45' S$; $70^{\circ}58' W$) (*Hassler* Voyage, MCZ).

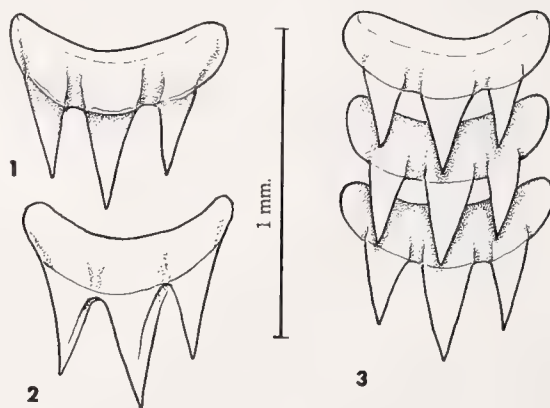


Plate 94. *Adelomelon ancilla* Solander. Off Río Colorado, Argentina. Length of radula 11 mm. Fig. 1. Front view of single tooth. Fig. 2. Back view of single tooth. Fig. 3. Three teeth in normal position.

Adelomelon (?) subnodosa Leach

Plates 95, 96

Voluta subnodosa Leach 1814, Zoological Miscellany 1: 24, pl. 8 (locality unknown). [Lectotype, here selected, in the British Museum, no. 1952.5.10.2.]

Voluta tuberculata Swainson 1821, Exotic Conchology, London, p. 19, pl. 29 (locality unknown); *ibid.* 1841, second edition, edited by S. Hanley, p. 19, pl. 29. [Holotype from the Broderip collection is in the British Museum.]

Voluta tuberculata Wood 1828, Index Testaceologicus, London, *Voluta*, pl. 3, fig. 22 (locality unknown).

Voluta tuberculata Wood. Lahille 1895, Revista del Museo de la Plata 6: 322, pl. 1, figs. 12-13; pl. 7, figs. 140-146; pl. 12, figs. 1-10. Lahille has described the following forms: *ferruginea*, p. 323; *decipiens*, p. 323; *fulgurea*, p. 323; *pseudofusiformis*, p. 324.



Plate 95. *Adelomelon subnodosa* Leach. After Leach, Zoological Miscellany 1814, p. 24, pl. 8.

Description. Shell medium to large, reaching 160 mm. (about $6\frac{1}{4}$ inches) in length, imperforate, strong in structure and sculptured. Color a dull yellowish orange with zig-zag axial lines of brown and with two broad and irregular, spiral bands of the same color. Whorls 6 and moderately convex. Spire moderately extended and formed at an angle of about 60° . Aperture semicircular. Siphonal canal broad and shallow, previous growth lines producing a fasciole. Outer lip thickened a little more above than below. Parietal wall with a heavy glaze which is sharply margined. Plicae 3 or 4. Columella short, straight and inclined to the right. Suture well-defined. Sculpture consisting of a series

of knobs along the edge of the whorl shoulder, usually 10 to 12 on the body whorl. Microscopic sculpture consisting of numerous and very fine, spiral threads. These threads are worn away on adult specimens. Protoconch consisting of 2 smooth whorls. Operculum, periostracum and radula unknown.

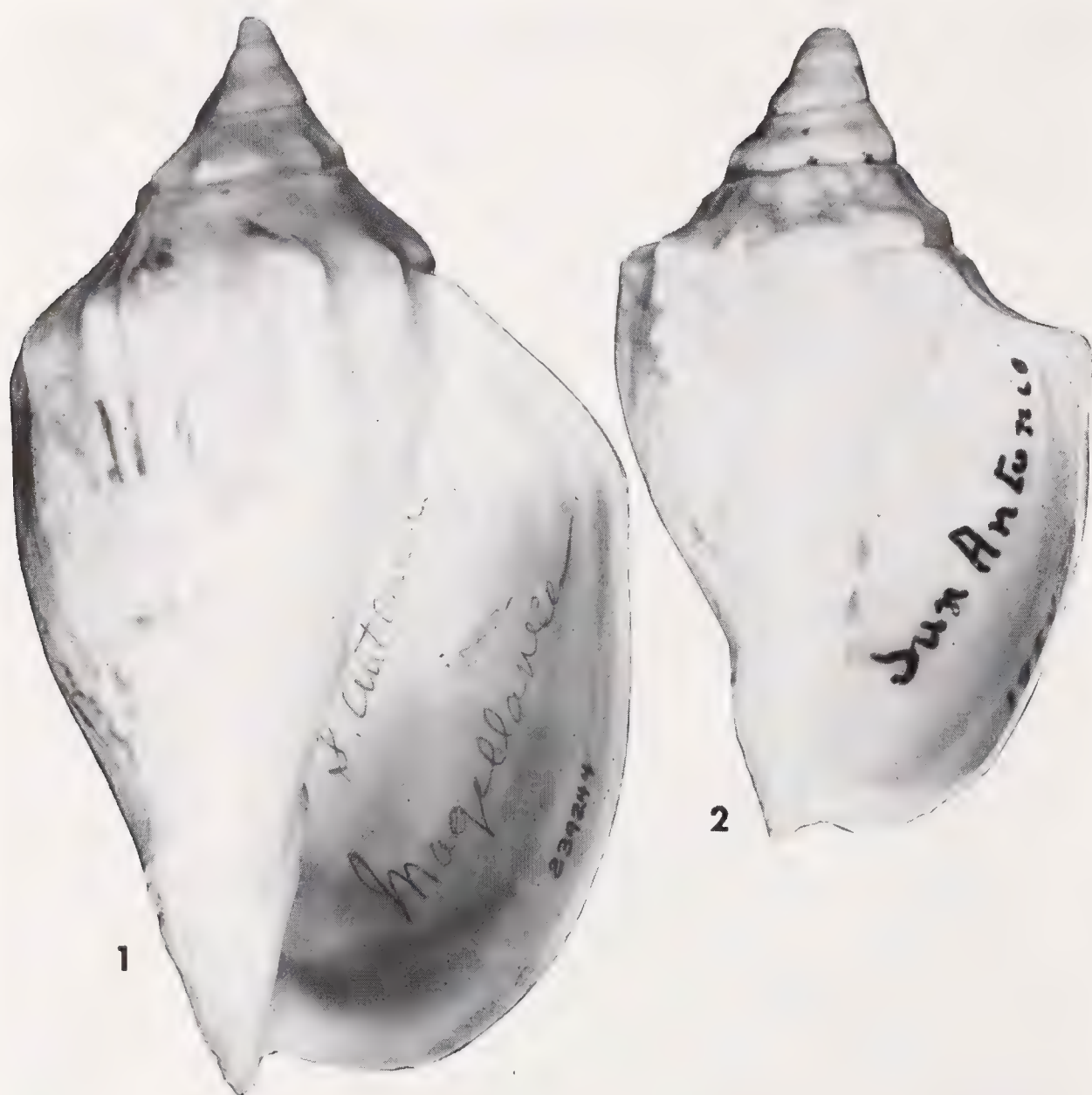


Plate 96. *Adelomelon subnodosa* Leach. San Antonio, Río Negro, Argentina. Fig. 1 (about natural size). Fig. 2 (2x).

length	width	
121.5 mm.	65 mm.	Holotype of <i>V. subnodosa</i> Leach
112	60	Holotype of <i>V. tuberculata</i> Swainson
160	91	San Antonio, Río Negro, Argentina

Remarks. This is a rare species and very little is known about it. There is no question that the figures of Leach for *subnodosa* and that of Swainson for *tuberculata* refer to the same species.

This species is placed provisionally in the genus *Adelomelon*. The radula is unknown, and until this is available its generic position will remain questionable. Dall (1907, p. 360) confused *subnodosa* with *O. americana* Reeve from off the Brazilian coast. This latter species is small, seldom exceeding two inches in length and is a warm water species.

Range. We make no attempt to define the range of this species because the confusion of names renders much of the associated data valueless. It probably extends south from San Antonio, Argentina to the Straits of Magellan.

Specimens examined. ARGENTINA: San Antonio, Río Negro, Patagonia (*Hassler* Voyage, MCZ; M. Birabén); off Río Negro (USNM).

Adelomelon (?) paradoxa Lahille

Plate 97

Voluta paradoxa Lahille 1895, Revista del Museo de la Plata **6**: 321, pl. 26, fig. 69; pl. 5, fig. 41; pl. 7, figs. 139, 147; pl. 12, figs. 17–21 (Argentina).

Cymbiola mangeri Preston 1901, Proc. Malacological Soc. London **4**: 237, text figure (Falkland Islands). [Holotype, British Museum, no. 1901.8.1.35.]

Description. Shell medium to large in size, reaching 172 mm. ($6\frac{3}{4}$ inches) in length, imperforate, solid and smooth. Color yellowish orange, inside the aperture a brownish orange. Whorls 6, moderately convex. Spire extended and produced at an angle of about 65° . Aperture semicircular. Siphonal canal broad and shallow, previous growth lines leaving a well-defined fasciole. Outer lip thick with the area below the whorl periphery slightly reflected. Parietal wall heavily glazed and with a well-defined margin. Plicae variable from 3 to 5.¹ Suture indented. Sculpture consisting of fine to rather coarse growth lines. Protoconch missing, as is the periostracum. Probably no operculum. Radula unknown.

length	width	
172 mm.	89 mm.	Falkland Islands
170	85	Puerto Deseado, Argentina

Remarks. We can add but little concerning this species. Nothing is known about its soft anatomy, so that its generic position will be in question until its radula can be examined.

Range. Southern Argentina and the Falkland Islands.

Specimens examined. ARGENTINA: Puerto Deseado, Patagonia (M. Birabén). FALKLAND ISLANDS: (MCZ).

Adelomelon (?) ferussacii Donovan

Plate 98

Voluta ferussacii Donovan 1824, Naturalists Repository **2**: pl. 67 (Straits of Magellan). [Type specimen lost.]

Voluta rudis Gray 1834 [in] Griffith and Pidgeon, Cuvier's Animal Kingdom **12**: 601, pl. 30, fig. 1 (locality not given). [Holotype, British Museum.]

Voluta oviformis Lahille 1895, Revista del Museo de la Plata **6**: 312, pl. 2, figs. 53–56; pl. 7, figs. 121–137; pl. 10, figs. 4–9. Lahille has described the following forms: *longiuscula*, p. 312; *fratercula*, p. 313.

Description. Shell medium in size, reaching 116 mm. (about $4\frac{1}{2}$ inches) in length, solid, imperforate and smooth. Color brown² with the aperture a brownish orange. Whorls 6 and convex. Spire depressed. Aperture semi-circular. Outer lip slightly flaring

¹ Only two specimens of this species available to us.

² We have not seen any specimens which have been collected alive.

but not reflected. Parietal area heavily glazed, the margin sharply defined. Plicae 3 to 6. Siphonal canal fairly broad but shallow, previous growth lines leaving a well-defined fasciole. Columella short. Suture indented. Sculpture consisting of both fine and coarse growth lines. Protoconch having $1\frac{1}{2}$ whorls and smooth. Operculum, periostracum and radula unknown.



Plate 97. *Adelomelon paradoxa* Lahille. Falkland Islands (about natural size).

length	width	
116 mm.	76 mm.	Tierra del Fuego, Argentina
96	65	Puerto Deseado, Argentina
91	53	Bahía San Gregorio, Chile

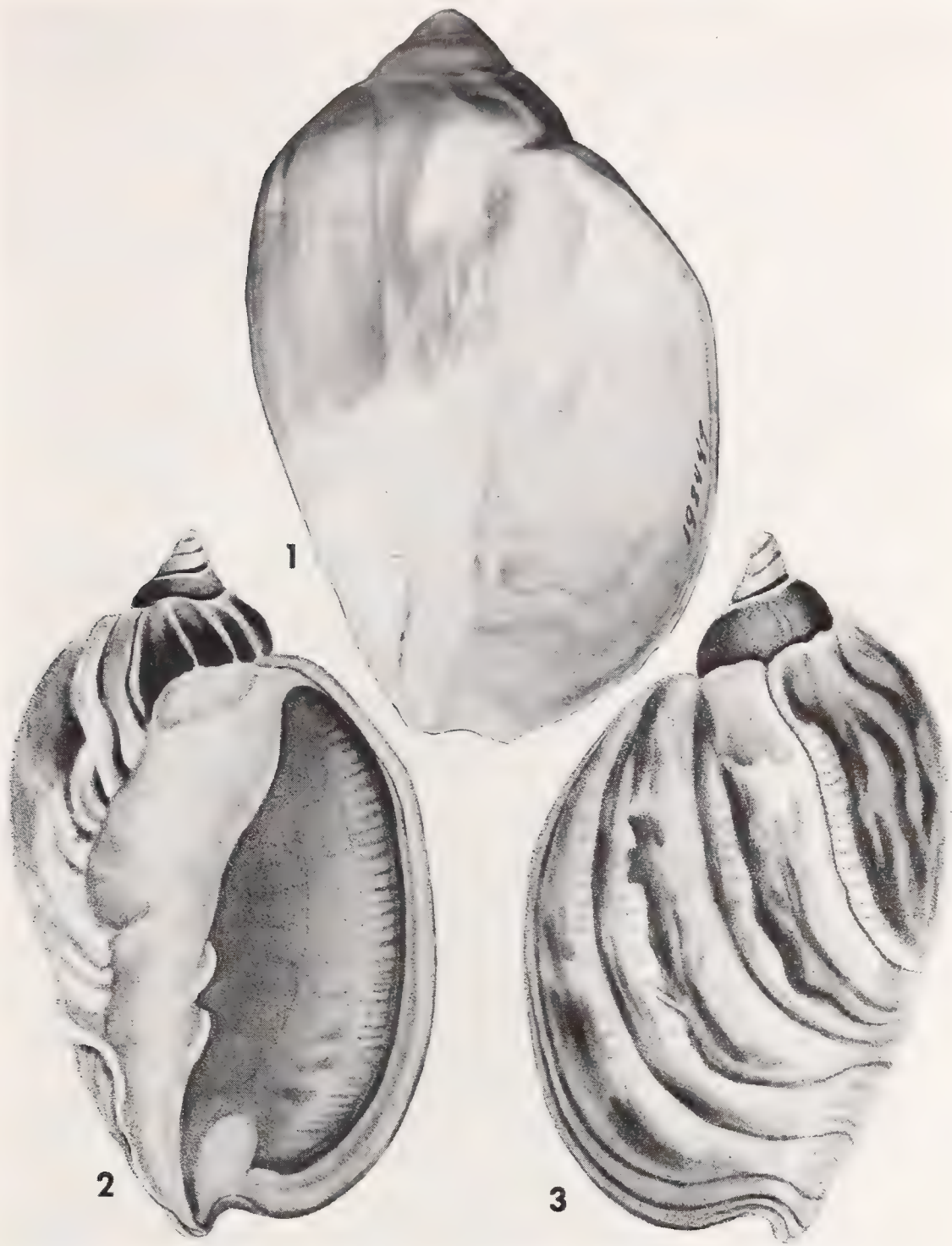


Plate 98. *Adelomelon ferussacii* Donovan. Fig. 1. Bahía San Gregorio, Straits of Magellan, Chile (about 1.1x). Figs. 2-3. Straits of Magellan, after Donovan 1824, *Naturalists Repository*, Vol. 2, pl. 67 (about natural size).

Remarks. Comparatively little is known about this species. All of our specimens were dead when collected, and this appears to be equally true for the specimens figured in most monographs. It very probably lives below the low water line. On the basis of shell characters it is most closely related to *Adelomelon brasiliana* (Lamarck).

Range. From latitude 42° S (Gulfo San Matias) south to the Straits of Magellan (Carcelles and Williamson, 1951).

Specimens examined. ARGENTINA: Puerto Deseado, Patagonia; Cabo Buen Tiempo, Gallegos Norte, Patagonia (both M. Birabén); Tierra del Fuego (A. Carcelles). CHILE: Bahía de la Posesión, Straits of Magellan (*Hassler* Voyage, MCZ); San Gregorio, Straits of Magellan (M. Birabén; USNM).

Adelomelon (Adelomelon) beckii Broderip

Plates 82, 99, 100

Voluta beckii Broderip 1836, Proc. Zool. Soc. London, p. 43 (locality unknown). [Lectotype, here selected, Cambridge Univ., Dept. of Zoology Museum, ex Saul collection. A syntype from the Broderip collection is in the British Museum.]

Voluta fusiformis Kiener 1839, Iconographie des Coquilles Vivantes, *Voluta* 3: 41, pl. 49 (l'Océan Méridional, les Côtes Magellaniques); non Brocchi 1814; Turton 1819; Swainson 1822; Defrance 1829.

Voluta festiva d'Orbigny 1841, Voyage dans l'Amérique Méridionale, Paris 5: 426 (south of the Rio Negro, near Ensenada de Rios); non Lamarek 1822.

Voluta fusiformis Kiener. Lahille 1895, Revista Museo de La Plata 6: 300, pl. 1, figs. 14-15; pl. 3; pl. 4. Lahille has described the following varieties: *ornata*, p. 301 and *connexa*, p. 302.

Voluta (Cymbiola) becki Broderip. Strebel 1906, Zoologische Jahrbucher 24: 97.

Adelomelon indigestus v. Ihering 1908, Anales Museo Nacional Buenos Aires (3) 10: 433, text fig. 2 (off the Ilha São Sebastião, São Paulo, Brasil; in the stomach of a fish).

Description. Shell large, reaching 450 mm. (about $17\frac{3}{4}$ inches) in length, imperforate, moderately solid and sculptured. Color a light orange-white, and with a few dark, brownish red, axial, zig-zag bands of color on the early whorls; the aperture orange. Whorls 7, moderately convex. Spire extended and produced at an angle of about 55° . Aperture semi-circular. Siphonal canal rather broad and shallow. Outer lip simple. Parietal wall with a glazed area which is sharply margined. Columella nearly straight and short. Plicae on the parietal wall two or three. Suture indented and well defined. Sculpture consisting of a series of knobs along the whorl shoulder, but these may be absent on the body whorl. Microscopic sculpture of very fine spiral threads which become nearly indistinct below the whorl periphery. Protoconch of $1\frac{1}{2}$ whorls and smooth. Periostracum probably present. No operculum. The radula is uniserial, rachidian teeth only, each consisting of three denticles, the central denticle being the longest.

length	width	
450 mm.	177 mm.	off Cabo Frio, Brasil
375	151	7 miles off Ilha Rasa, Est. Rio de Janeiro, Brasil
368	141	" " " " " " " "
365	149	" " " " " " " "
282	129	Puerto Quequén, Argentina
231	102	Ilha Sant'Anna, Macaé, Est. Rio de Janeiro, Brasil
220	90	Lectotype of <i>Adelomelon beckii</i> Brod.

Remarks. This is the largest species in the Volutidae known from the Western Atlantic. In relationship it appears to be nearest to *Adelomelon ancilla* Solander, but has a much larger and heavier shell and has shoulder knobs which are not found in *A. ancilla*.

Carcelles states that *A. beckii* occurs on sand in the littoral zone. Dr. Tursch has reported in a letter that this species is an important item of food of the fisherman and is also sold in the markets in Rio de Janeiro.

Range. This species extends from southern Brasil, possibly as far south as Tierra del Fuego, and is found in the Falkland Islands according to Carcelles (1951, p. 302).

Specimens examined. BRASIL: Ilha de Sant'Anna, off Macaé, Est. Rio de Janeiro (J. W. Donovan); off Cabo Frio (B. Tursch); off Rio de Janeiro (ANSP); 7 miles off Ilha Rasa, Est. Rio de Janeiro, in 32 fathoms, sand and mud bottom (B. Tursch); off southern Albardão, Rio Grande do Sul (E. de C. Rios). ARGENTINA: Puerto Quequén, Prov. Buenos Aires (A. Carcelles; MCZ; ANSP).



Plate 99. *Adelomelon beckii* Broderip. Ilha de Sant'Anna, Est. de Rio de Janeiro, Brasil (about $\frac{2}{3}$ x).

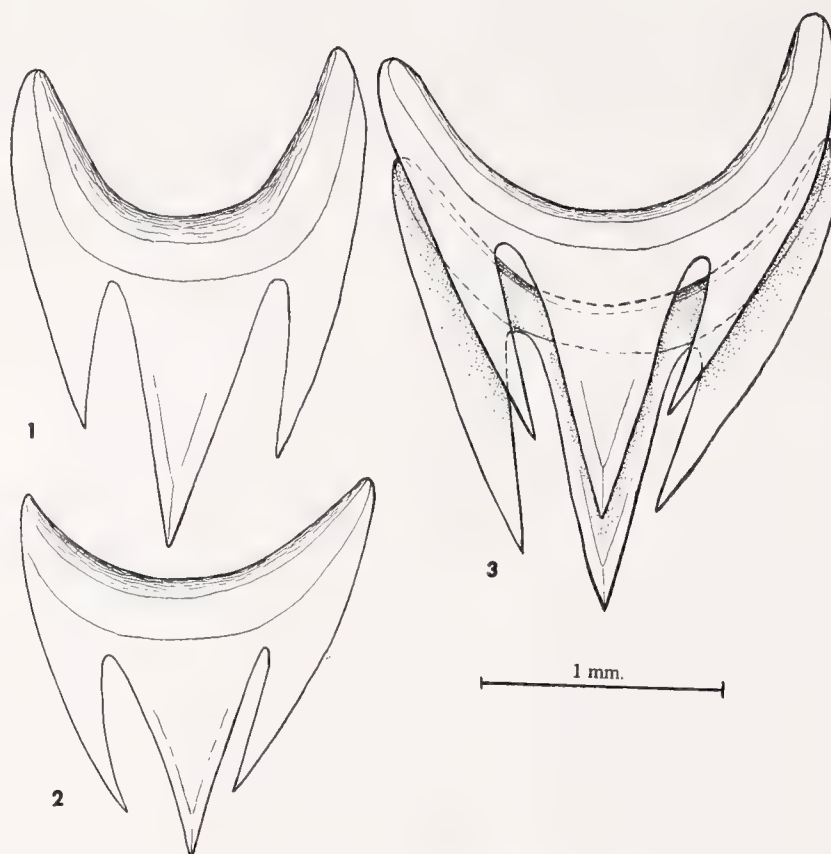


Plate 100. Radula of *Adelomelon beckii* Broderip. Off Rio de Janeiro, Brasil. Length of radula 48 mm. Fig. 1. Single tooth from near the forward end. Fig. 2. Single tooth from near the back end. Fig. 3. Two teeth in normal position.

Weaveria, new subgenus

This subgenus is characterized by having a very small protoconch in proportion to the size of the adult and by having a very thick deciduous periostracum. There is no indication of any zig-zag color markings, and the whorls are far more globose than in other species in the genus *Adelomelon*.

Named for Clifton S. Weaver of Honolulu.

Type species, *Adelomelon (Weaveria) riosi* Clench and Turner.

Adelomelon (Weaveria) riosi, new species

Plates 83, 101, 102

Shell reaching 245 mm. (about $9\frac{1}{2}$ inches) in length, imperforate and sculptured. Color a dark reddish brown (periostracum); the shell itself, a light, diffused orange. Interior of aperture a bright orange. Whorls 6 and convex. Spire extended, forming an angle of 50° to 60° . Aperture semicircular. Outer lip thin and simple. Parietal wall with a broad aluminum glazed area which is sharply margined. Columella nearly straight. Plicae on the parietal wall variable, from none to two. Suture impressed. Sculpture consisting of numerous, fine, incised, spiral threads on the bulge of the whorl shoulder. Protoconch consisting of two small whorls and having a short calcarella. Periostracum deciduous, but where present is rather thick. No operculum present on either of the two preserved specimens.

The radula is uniserial, rachidian teeth only, each having three, sharp, subequal, pointed denticles in one plane.



Plate 101. *Adelomelon riosi* Clench and Turner. From 130 miles east of Mar del Plata, Argentina, in 99 fathoms. Holotype (about natural size).

length	width	
245 mm.	107 mm.	Paratype
214	106	Paratype
207	102	Holotype
201	104	Paratype
193	101	Paratype

Types. The holotype is in the Museum of Comparative Zoology, no. 245017, from about 130 miles east of Mar del Plata, Argentina in 99 fathoms. Paratypes from about 150 miles ESE of Cabo San Antonio ($36^{\circ}40' S$; $53^{\circ}08' W$) [$54^{\circ}08' W?$] in 95 fathoms. Paratypes in the United States National Museum, no. 652353; Museo Oceanográfico de Rio Grande, no. 8.221; and in the collection of Clifton S. Weaver.

The longitude given above as $53^{\circ}08' W$ appears to be in error, as the depth at this point is well over 1000 fathoms. $54^{\circ}08' W$ would agree with the depth given as well as the distance off shore. The material and data were received from the fishing vessel *Pescal II*.

Remarks. This is one of the larger species in the Volutidae in the Western Atlantic, being exceeded only by *Adelomelon beckii* Broderip. It is, however, quite variable in size. The five specimens in the type series appear to be about the same age, but the measurements given above show a range in length from 193 to 245 mm.

On the basis of the radula and the soft anatomy this species is an *Adelomelon*. The shell morphology is somewhat different from the other species in this genus, though only in degree. The shape of the shell is somewhat like that of *Guivillea alabastrina* Watson, but *A. riosi* is larger, much heavier, and has a much smaller protoconch. *A. riosi* was dredged in 95 to 99 fathoms from off Argentina, while *Guivillea* was dredged in 1600 fathoms between Marion Island and the Crozets in the South Indian Ocean. The radula and soft anatomy of *Guivillea* are unknown.

Named for E. de Carvalho Rios of the Museu Oceanográfico de Rio Grande. The stomach contents of *A. riosi* consisted of fragments of an *Astropecten*.¹

Range and Specimens examined. See under *Types*.

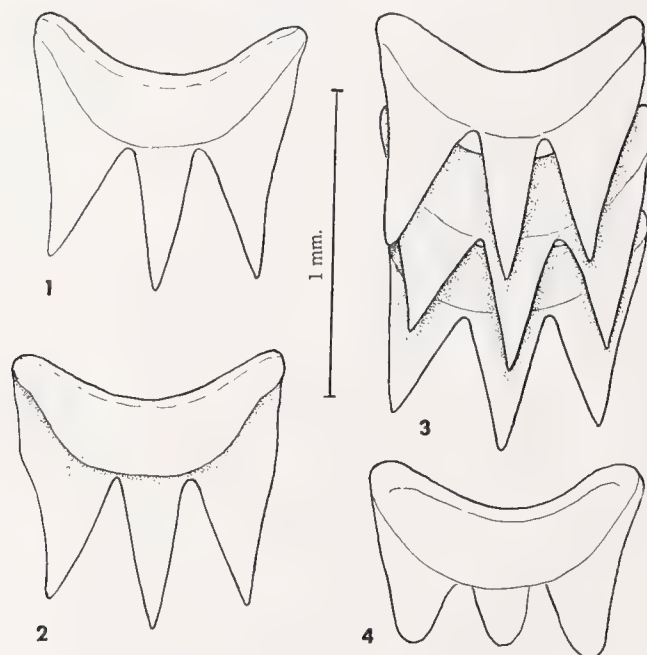


Plate 102. Radula of *Adelomelon riosi* Clench and Turner. About 150 miles ESE of Cabo San Antonio, Argentina. Length of radula 12 mm. Fig. 1. Front view of a single tooth. Fig. 2. Back view of a single tooth. Fig. 3. Three teeth in normal position. Fig. 4. Old tooth showing wear.

¹ Determination by Dr. E. Deichmann.

Subgenus **Pachycymbiola** von Ihering

Pachycymbiola von Ihering 1907, Anales Museo Nacional de Buenos Aires (3) 7: 209.

Type species, *Voluta brasiliiana* Lamarck, original designation.

Shells medium to large in size, subglobose, heavy, smooth or tuberculate and with a thick periostracum.

The radula is typical of that for the genus, but the shell and protoconch differ from typical *Adelomelon*, as shown on Plate 82.



Plate 103. *Adelomelon brasiliiana* Lamarck. Fig. 1. Punta del Este, Maldonado, Uruguay (about natural size). Fig. 2. Egg case, Punta del Este, Maldonado, Uruguay (1.25x). Fig. 3. About 112 miles east of Punta Piedras, Argentina (natural size).

***Adelomelon (Pachycymbiola) brasiliiana* Lamarck**

Plates 82, 103, 104, 105

Voluta brasiliiana Solander 1786, Catalogue of the Portland Museum, p. 186, no. 3958 [nomen nudum].

Voluta brasiliiana Lamarck 1811, Annales Muséum d'Histoire Naturelle 17: 62. [Based upon Chemnitz 1795, Conchylien-Cabinet (1) 11: pl. 176, figs. 1695-1696] (Brasil).¹

¹ The holotype of *Voluta brasiliiana* Lamarck, stated by Kiener to be in the Paris Museum, could not be located by Dr. D. F. McMichael in 1961. The type figure, however, is that of Chemnitz to which Lamarck referred, as given in the synonymy above.

Voluta colocynthis Dillwyn 1817, A Descriptive Catalogue of Recent Shells 1: 574 (inhabits the coast of Brasil).

Voluta colocynthis 'Chemnitz' Dillwyn. Lahille 1895, Revista Museo de La Plata 6: 302, pl. 1, figs. 3-4; pl. 2, figs. 50, 52, 57, 60; pl. 5. Lahille has described the following forms: *lactea*, p. 304; *intermedia*, p. 304; *globosa*, p. 305, non Dillwyn 1817; *depressa*, p. 305, non Lamarck 1802; *pseudomagellanica*, p. 305; *subcarinata*, p. 305; *carinata*, p. 305, non Zekeli 1852; *alternata*, p. 306; *spirabilis*, p. 306.

Pachycymbiola brasiliana Lamarck. von Ihering 1907, Anales Museo Nacional de Buenos Aires (3) 7: 209.

Cymbiola brasiliana (Solander). Barattini and Ureta 1960, La Fauna de las Costas Uruguayas del Este, Montevideo, p. 123, pl. 36.

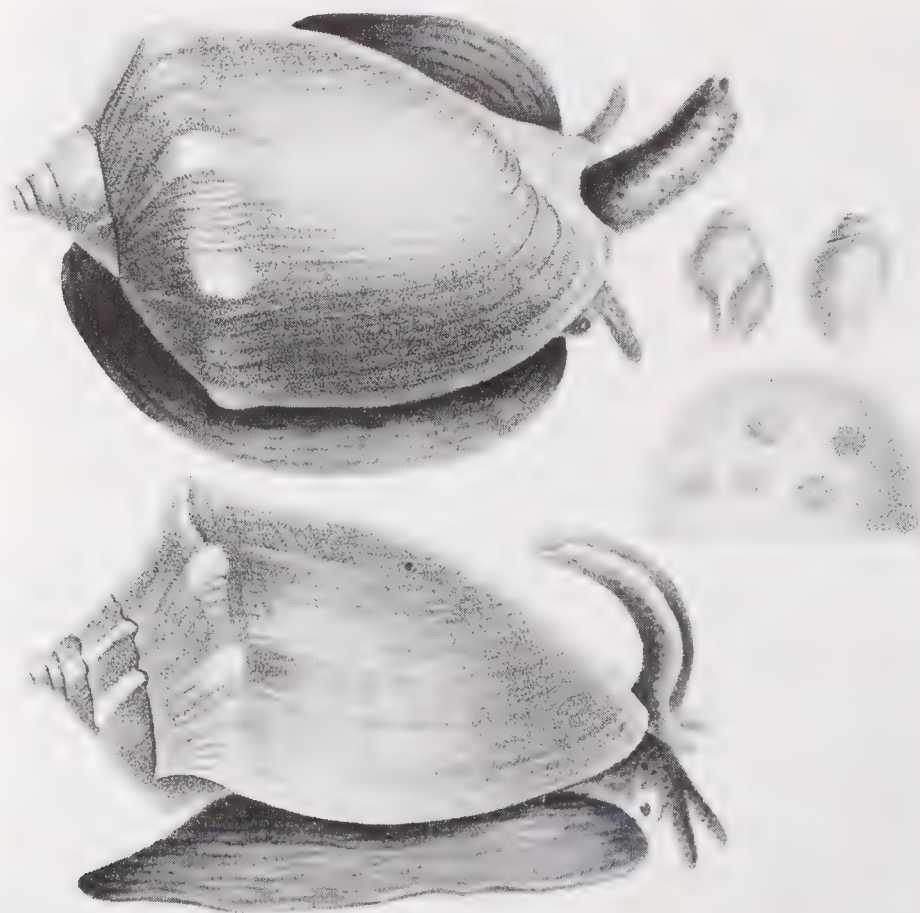


Plate 104. *Adelomelon brasiliana* Lamarck. After A. d'Orbigny 1847, Voyage dans l'Amérique Méridionale, pl. 60. Showing the egg capsule and the young (about $\frac{2}{3}x$).

Description. Shell medium to large in size, reaching a length of 183 mm. ($7\frac{1}{4}$ inches) solid, imperforate and nodulose. Color grayish white, overlaid with a thick, blackish brown periostracum. Aperture a light, brownish orange. Whorls 6, and moderately convex. Spire only slightly extended and produced at an angle of about 105° . Aperture semicircular. Siphonal canal broad and shallow, which has produced in its previous growth stages a well-marked fasciole. Outer lip simple. Parietal area with a heavy glaze which is sharply margined. There are two to four plicae, the lower one being the largest. Columella short and arched. Suture slightly indented. Sculpture consisting of numerous, fine to coarse growth lines. On the whorl shoulder there is a single row of well-developed knobs. Protoconch with one and one-half whorls and rather small. Probably without an operculum.

The foot, head and siphonal canal are colored a finely mottled purple, the foot about equal to the length of the shell. The young are subglobose and have a very short rounded calcarella. The young of *A. ancilla* Solander are attenuated and have an extended, pointed calcarella.

The radula is uniserial, consisting only of rachidian teeth, each tooth with three denticles about equal in size.

length	width	
183 mm.	117 mm.	Banco Ingles, Maldonado, Uruguay
161	111	Puerto Deseado, Patagonia, Argentina
141	93	Praia de Imbituba, Est. Santa Catarina, Brasil

Remarks. This is a large and heavy species. Carcelles (1944, p. 254) reports it to be very abundant on the sandy beaches at Cabo San Antonio and at Mar del Plata, Argentina. It occurs in the intertidal and littoral zones.

This species produces an ovicapsule which may contain five to fifteen embryos.

Range. From the southern coast of Brazil and south at least as far as Deseado, Patagonia, Argentina.

Specimens examined. BRASIL: 20 miles off Punta de Juatinga, Est. Rio de Janeiro, in 35 fathoms, mud bottom; 10 miles off Ilha de São Sebastião, Est. São Paulo, in 30 fathoms, mud bottom (both B. Tursch); Praia de Imbituba, Est. Santa Catarina (M.J. de Oliveira); Rio Grande do Sul (MCZ); Chuí and Sarita, Est. Rio Grande do Sul (both ANSP). URUGUAY: Cabo Polonio (=Cabo Castillo); Cabo Santa Maria (both USNM); Maldonado (MCZ); Punta del Este, Maldonado; Banco Ingles, about 50 miles SE of Maldonado (both E. Duarte); La Paloma and Piriapolis (both ANSP). ARGENTINA: about 112 miles E of Punta Piedras ($35^{\circ}12' S$; $55^{\circ}30' W$) in 7 fathoms (*Hassler Voyage*, MCZ); off Punta Medanos, Prov. Buenos Aires (A. Carcelles); Mar del Plata; Monte Hermosa; off Rio Negro (all USNM); Puerto Deseado, Patagonia (M. Birabén).

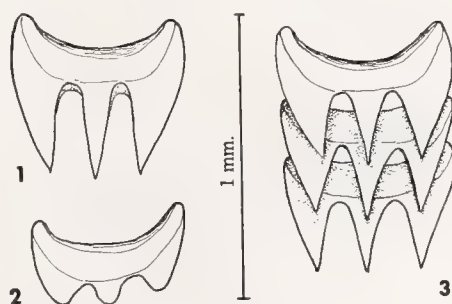


Plate 105. *Adelomelon brasiliiana* Lamarek. Off Isla Lobos, Uruguay. Length of radula 7 mm.
Fig. 1. Single tooth. Fig. 2. Old tooth showing wear. Fig. 3. Three teeth in normal position.

Genus *Provocator* Watson

Provocator Watson 1882, Jour. Linnean Society London **16**: 329; *ibid.* 1886, Voyage of H.M.S. *Challenger* **15**: 260, pl. 13, fig. 5.

Type species, *Provocator pulcher* Watson, monotypic.

The shells are thin, very finely sculptured with both growth lines and spiral striae. The siphonal canal is broad and shallow, the anal canal narrow and deep. Columellar plicae one or two. On the ventral surface of the shell the glazed area extends over the earlier whorls.

Provocator corderoi Carcelles

Plates 106, 107

Provocator corderoi Carcelles 1947, Comunicaciones Zoologicas del Museo de Historia Natural de Montevideo 2 (40): 5, pl. 1, figs. 1-5 (about 100 miles ESE of Necochea, Argentina [$39^{\circ}00' S$; $57^{\circ}10' W$] in 97 fathoms). [Holotype in the National Museum, Buenos Aires, Argentina.]

Description. Shell rather small, reaching 64 mm. ($2\frac{1}{2}$ inches) in length, thin, imperforate and finely sculptured. Color a porcelain white covered with a thin, light brown periostracum. Whorls 5, slightly convex. Spire moderately extended and produced at an angle of 50° . Aperture irregularly semicircular with a broad and shallow siphonal canal below. Outer lip thin, simple and slightly reflected. Parietal wall glazed, the glaze extending to just below the tip of the spire. Columella short and spiral with one or two plicae. Suture broadly impressed and covered by the glaze. Anal canal narrow. Area of the canal forming a narrow, slanting shoulder on the whorl, which is somewhat thickened and china-white in color. Sculpture consisting of very fine growth lines and exceedingly fine and rather indistinct spiral threads. Protoconch glazed over.



Plate 106. *Provocator corderoi* Carcelles. About 135 miles east of Cabo San Antonio, Argentina (about 2x).

Posterior end of the foot an intense bright orange becoming gradually light and diffused anteriorly, the anterior end of the foot being a light salmon color. Mantle light salmon with a bright orange band just inside the edge. Siphon bright orange. Lateral lobes of head and tentacles orange; the broad central lobe a light orange shading to tan at the center. Under surface of foot a uniform ivory. Head very broad and flat; tentacles short and broad. Eyes small, black and located at the base of the tentacles on the lateral lobes. Siphon with two equal basal lobes which in preserved specimens are nearly as long as the siphon. The single animal we had for study was too poorly preserved for detailed anatomical work, but sufficient could be observed to allow us to state definitely that it agrees with the characters of the subfamily Zidoninae. The radular teeth are extremely heavy, though typical of the subfamily.

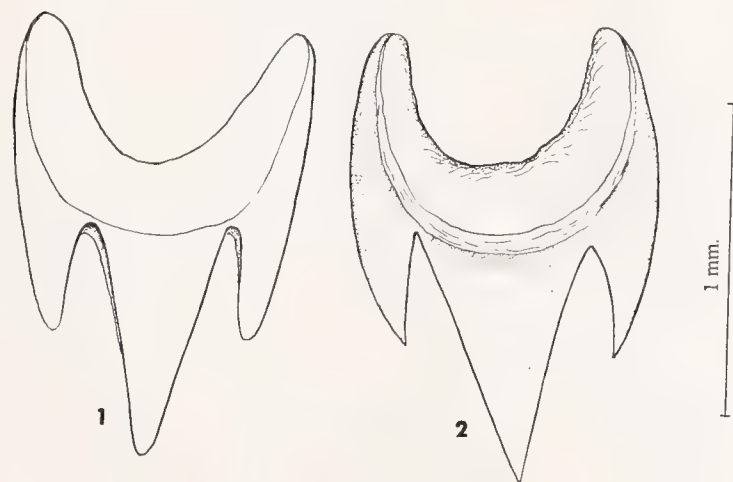


Plate 107. *Provocator corderoi* Carcelles. Fig. 1. Outer view of single worn tooth taken from the anterior end of the ribbon. Fig. 2. Back view of a single tooth taken from the middle of the ribbon and showing thickened ridge which is attached to the ribbon.

length	width	
64 mm.	30 mm.	135 miles east of Cabo San Antonio, Argentina
59	29	about 150 miles east of Cabo San Antonio, Argentina
63	33	Holotype
52	29	about 135 miles east of Mar del Plata, Argentina

Remarks. This is the second known species in this genus. *Provocator pulcher* Watson was dredged by the *Challenger* in the southern Indian Ocean between Kerguelen and Heard Islands in 150 fathoms and off Cumberland Bay, Kerguelen Island in 105 fathoms.

P. corderoi differs from *P. pulcher* by being smaller and in having fewer whorls and proportionately a more reduced spire. In depth, *P. corderoi* ranges from 30 to 85 fathoms.

We are most grateful to Dr. Rios for the soft parts of *Provocator corderoi* Carcelles. Unfortunately, the shell was completely broken, but enough remained for Dr. Rios to determine it. The specimen was dredged by L. R. Pontes of the fishing vessel *Pescal II* off Cabo San Antonio, Argentina in 80 fathoms.

Range. The few records available are not sufficient to determine the range of this species. The five stations given by Carcelles all fall within a distance of 180 nautical miles.

Specimens examined. ARGENTINA: about 135 miles E of Cabo San Antonio (36°10' S; 54°20' W) in 38 fathoms; about 150 miles E of Cabo San Antonio in 85 fathoms (both C. Weaver).

Odontocymbiolinae, new name

Adelomeloninae Pilsbry and Olsson 1954, Bull. American Paleontology **35**: 289.

The type genus of this subfamily is *Adelomelon* Pilsbry and Olsson 1954; non Dall 1906. Unfortunately at the time Pilsbry and Olsson recognized the validity of the subfamily for which they introduced the name *Adelomeloninae* they misidentified the species



Plate 108. *Odontocymbiola magellanica* Gmelin. Figs. 1-2. Shoal Bay, Straits of Magellan, Chile. Hassler Voyage, 1872 (about natural size).

and genus on which the name was based. Thus *Adelomelon* Pilsbry and Olsson 1954 is a homonym of *Adelomelon* Dall 1906, the two genera actually belonging to different subfamilies. Consequently, it is necessary to institute a new name, not only for the genus, but also for the subfamily.

Radula uniserial, rachidian teeth only, with a base plate and three prong or fang-like denticles. This subfamily includes *Odontocymbiola* (new) and possibly *Miomelon* Dall 1907. See also *Zidoninae*, p. 147.

Odontocymbiola, new name

Adelomelon 'Dall' Pilsbry and Olsson 1954, Bull. American Paleontology **35**: 280, 289 and 306; non Dall 1906.

Type species, *Adelomelon ancilla* 'Solander' Pilsbry and Olsson, monotypic (= *Voluta magellanica* Gmelin).

Shells medium to large in size, attenuated and with strongly convex whorls. Surface relatively smooth. Axial zig-zag lines of color rather weak, particularly in old specimens. Radula uniserial, rachidian teeth only, each tooth with three, pointed and fang-like denticles which extend at a right angle from the basal plate and then curve downwards. (See Plate 82.)

Remarks. Pilsbry and Olsson were in error by figuring these fang-like rachidian teeth under *Adelomelon ancilla* (Solander). *Adelomelon* has a rake-like, three-pronged tooth, the denticles being more or less in the same plane. See *Remarks* under *A. ancilla*.

***Odontocymbiola magellanica* Gmelin**

Plates 82, 83, 108, 109

Voluta magellanica Gmelin 1791, Systema Naturae, ed. 13, 6: 3465 (Straits of Magellan). [Based upon Chemnitz 1788, Conchylien-Cabinet (1) 10: 138, pl. 148, figs. 1383-1384.]; non *V. magellanica* Lamarck 1811.

Voluta magellanica 'Chemnitz' Lahille 1895, Revista del Museo de la Plata 6: 317, pl. 1, fig. 1; pl. 2, figs. 64-65; pl. 7, figs. 148-149, 154; pl. 8; pl. 12. Lahille has introduced the following named forms: *curta* and *taeniolata*, p. 318.

Voluta ambigua Lahille 1895, Revista del Museo de la Plata 6: 319, pl. 2, fig. 61; pl. 8, figs. 163-164; pl. 11, figs. 6, 9, 11; pl. 12, figs. 11-16 (Argentina). Lahille has introduced the following named forms: *subnodosa*, p. 319, non Leach 1814; *constricta*, p. 320; *pseudotuberculata*, p. 320.

Adelomelon ancilla 'Solander' Pilsbry and Olsson 1954, Bull. American Paleontology 35: 306, pl. 28, fig. 6; non *Voluta ancilla* Solander 1786.

Description. Shell reaching 190 mm. ($7\frac{1}{2}$ inches) in length, imperforate and smooth. Color a light ivory with a few irregular, narrow, zig-zag, axial bands of brown; inside the aperture a light salmon and highly glazed. Whorls 5 and moderately convex. Spire moderately extended and produced at an angle of from 55° to 65° . Aperture semicircular, with a broad, shallow siphonal canal. Outer lip thin and simple. Parietal wall glazed, sharply margined and having 3 or 4 well-defined plicae. Columella straight to slightly arched. Suture indented, occasional specimens showing pointed crenulations on the body whorl. Sculpture consisting of fine, irregular growth lines; occasional speci-

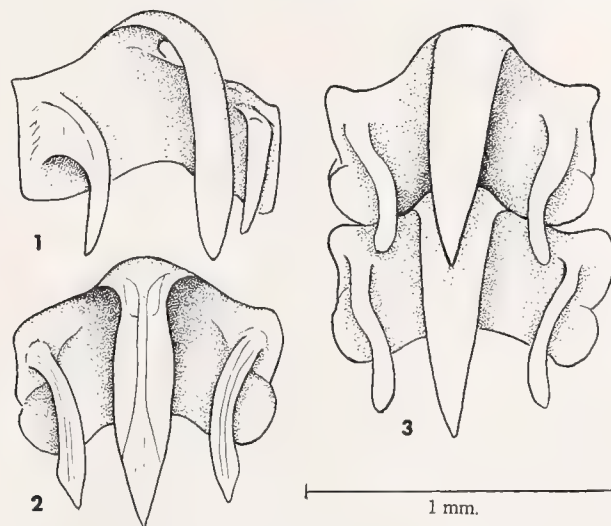


Plate 109. Radula of *Odontocymbiola magellanica* Gmelin. Shoal Bay, Straits of Magellan, Chile. Length of radula 12 mm. Figs. 1-2. Single teeth. Fig. 3. Two teeth in normal position.

mens being tuberculate on the whorl shoulder. Protoconch small and poorly defined. Periostracum deciduous. Operculum lacking.

Radula uniserial, consisting of rachidian teeth, each tooth with three denticles which are fang-like.

length	width	
190 mm.	76 mm.	San Gregorio, Straits of Magellan, Chile
122	56	Shoal Bay, Straits of Magellan, Chile
111	50	Shoal Bay, Straits of Magellan, Chile

Remarks. In shell characters this species is nearest to *Adelomelon ancilla* Solander, differing by being proportionately broader, having a wider and more capacious aperture and a more solid shell. The radula of *Odontocymbiola magellanica* Gmelin differs remarkably from *Adelomelon ancilla* Solander. In *magellanica* the denticles or cusps are fang-like and project outward and down, each denticle forming an arc. A somewhat similar radula to that of *O. magellanica* is found in *Miomelon philippianus* Dall from the southwest coast of Chile (677 fathoms). The shell, however, is very different.

Range. From off Río de La Plata in Argentina south to the Straits of Magellan; north to Chiloe Island, Chile and the Falkland Islands.

Specimens examined. ARGENTINA: about 155 miles E of Cabo San Antonio in 81 fathoms; SE of Punta Médanos (both C. Weaver; E. Rios); off Mar del Plata, Prov. Buenos Aires (A. Carcelles); Puerto Quequén (USNM); *Albatross*, Station 2768, about 275 miles ENE of Cabo Delgada ($42^{\circ}24' S$; $61^{\circ}38' W$) in 61 fathoms (USNM); Puerto Deseado, Patagonia (M. Birabén). CHILE: Shoal Bay, Straits of Magellan ($52^{\circ}55' S$; $70^{\circ}52' W$) (*Hassler* Voyage, MCZ); San Gregorio, Straits of Magellan ($52^{\circ}37' S$; $70^{\circ}12' W$) (MCZ; USNM); Burnt Id., Bahía Orange (USNM). FALKLAND ISLANDS: (MCZ); Port Stanley (USNM).

Odontocymbiola pescalía, new species

Plates 110, 111

Shell reaching 103 mm. (about 4 inches) in length, imperforate and finely sculptured. Color a uniform dull, grayish tan with a faint indication of spiral bands of brown. The fasciole is brown; interior of aperture salmon. Whorls 5 and strongly convex. Spire moderately extended and produced at an angle of about 50° . Aperture subovate. Outer lip thin and simple. Parietal wall with a broad glazed area which is sharply margined. Columella nearly straight and with 3 strong plicae. Suture deeply impressed. Spiral sculpture consisting of numerous, fine, incised, spiral threads which are strongest on the early whorls. Axial sculpture consisting of fine growth lines. Protoconch small and poorly defined. Periostracum probably thin and deciduous. Operculum lacking.

Radula uniserial, consisting of rachidian teeth, each tooth with three fang-like denticles.

Upper surface of the foot a mottled salmon pink, edged with ivory; the under surface a uniform ivory. Head with a central and two large lateral lobes; the tentacles located at the junction of the lobes. Eyes minute, black and located on the lateral lobes at the base of the tentacles on their outer side. Head a mottled salmon, edged with ivory; the tentacles and mantle ivory. Siphon ivory, with two large equal lobes at the base. Osphra-

dium and gill set well back from the base of the siphon. Anatomy similar to that of *Odontocymbiola magellanica* and *americana*.

length	width	
103 mm.	45 mm.	160 miles ENE of Mar del Plata, Argentina



Plate 110. *Odontocymbiola pescalía* Clench and Turner. Fig. 1. Apertural view of Holotype. Fig. 2. Side view to show fasciole (about natural size).

Types. The holotype is in the Museum of Comparative Zoology, no. 233795, from about 160 miles ENE of Mar del Plata, Argentina, on a mud bottom. Collected by the fishing vessel *Pescal II* and received from E. de Carvalho Rios of the Museu Oceanográfico de Rio Grande, Brasil.

Remarks. This species differs from *O. magellanica* Gmelin in having more convex whorls, having a fine spiral sculpture and a much more highly developed fasciole which extends beyond the base of the columella. In addition, the spire is more attenuated in *O. pescalía*, being seven-tenths the length of the aperture, while in *O. magellanica* the spire is one-half the aperture length.

O. pescalía resembles superficially *Adelomelon riosi*, but differs in being much smaller and in having a very different radula.

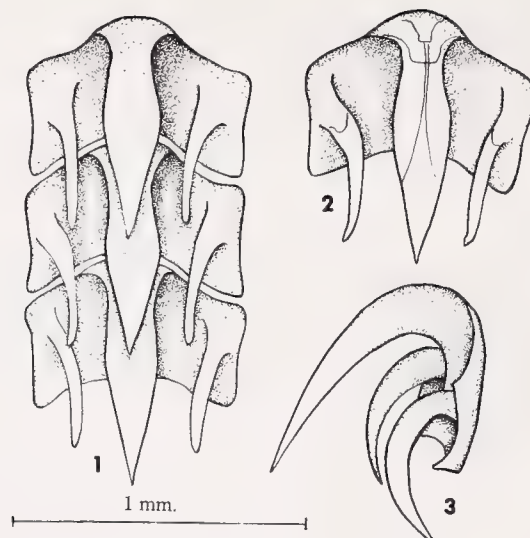


Plate 111. Radula of *Odontocymbiola pescalia* Clench and Turner. Fig. 1. Three teeth in normal position. Fig. 2. Single tooth showing structure. Fig. 3. Side view of single tooth.

Odontocymbiola americana Reeve

Plates 81, 82, 112, 113

Voluta americana Reeve 1856 (June), Proc. Zool. Soc. London, pt. 24, p. 2, pl. 33, figs. 1-2 (Brasil). [Type specimen lost.]¹

Voluta cleryana Petit de la Saussaye 1856 (November), Jour. de Conchyl. 5: 182, pl. 6, figs. 3-4 (Cap Saint Thomé [Cabo de São Tomé] Brasil in 40 fathoms). [Holotype in the collection of the Jour. de Conchyl. in Paris, France.]

Description. Shell small, reaching 59 mm. ($2\frac{3}{8}$ inches) in length, rather light in structure, imperforate and sculptured. Color a light, yellowish gray without markings, to a light brownish orange with numerous zig-zag lines of brown in axial arrangement. Occasional specimens with a few dark spots. Whorls 6 and slightly convex. Spire moderately extended and produced at an angle of 45° to 60° . Aperture semicircular. Siphonal canal shallow and narrow with previous growth lines forming a fasciole. Outer lip thin and simple. Parietal area thinly glazed. Plicae 4 or 5 and variable in size. Columella short. Suture slightly indented and well-defined. Sculpture consisting of a series of knobs at the base of the whorl shoulder. Surface of the shell smooth. Probably no periostracum.

Dr. Bernard Tursch in a letter says that "The animal is of a uniform color, a rich yellow-beige, without design. It has no operculum."

length	width	
63.5 mm.	30.1 mm.	off Macaé, Brasil
59	25.5	Ilha de Sant'Anna, Macaé, Brasil
47	27	Ilha de Sant'Anna, Macaé, Brasil
52	31	Cananéa, São Paulo, Brasil
40	20	Lage dos Santos, São Paulo, Brasil
35	17	Holotype of <i>cleryana</i> Petit
46	25	Holotype of <i>americana</i> Reeve
34.5	18	Ilha do Pai, Rio de Janeiro, Brasil
32	15.5	Ilha do Pai, Rio de Janeiro, Brasil

¹ In a letter from D. F. McMichael: "ex. Cathcart collection, sold and now lost."

Remarks. This species has been considered a synonym of *Adelomelon subnodosa* (Leach) in most monographs. *O. americana*, however, is a very different species and is as well in a different genus. Confusion existed because young shells of *subnodosa* are somewhat



Plate 112. *Odontocymbiola americana* Reeve. Figs. 1-3. Off Ilha de Sant'Anna, near Macaé, Brasil in 25 fathoms (1.65x). Figs. 4-5. Off Ilha de Pai, Brasil in 6 fathoms. ANSP no. 272512. Photographs of Figs. 4-5 from Clifton Weaver (2.17x).

similar. The adult animal of *subnodosa* produces a shell of at least 160 mm. ($6\frac{1}{4}$ inches) in length, while that of *americana* reaches only 63 mm. ($2\frac{1}{2}$ inches) in length. Dall considered the shells figured in the original descriptions of *americana* and *cleryana* as young specimens, as have others, but most specimens of this species we have examined are adult. Young specimens of *subnodosa* are easily separated from *americana* by having a well-marked shoulder angle, as well as being proportionately broader and in having a different color pattern.

O. americana Reeve is exceedingly variable in just about all of its characters. The measurements above indicate how disproportionate individual specimens may be in the

ratio of height to width. *O. americana* is most closely related to *O. magellanica* Gmelin, as both species have fang-like rachidian teeth. The shells, however, are quite different: *americana* is a small species which always has a series of knobs on the whorl shoulder, while *magellanica* is large and only occasional specimens have tubercles on the whorl shoulder.

Dr. Tursch reports in a letter that he dredged this species on hard sand and shell fragments and below 15 fathoms.

Range. From Macaé, Est. Rio de Janeiro southwest to Cananéa, Est. São Paulo, Brasil. This is a distance of about 400 miles.

Specimens examined. BRASIL: Ilha de Sant'Anna, near Macaé, Est. Rio de Janeiro in 15 and 25 fathoms (C. Weaver; B. Tursch); Ponta de Jostinga, Est. Rio de Janeiro (Museo Nacional, Montevideo); (2 miles S of Ilha do Pai, Rio de Janeiro ($43^{\circ}04' W$; $23^{\circ}01'30'' S$) in 19 fathoms (ANSP; B. Tursch); off Ilha Raza, Rio de Janeiro in about 20 fathoms (B. Tursch); Lage dos Santos, 25 miles SE of Santos, Est. São Paulo; Caranéa, Est. São Paulo (both Museo Nacional, Montevideo).

Subfamily CALLIOTECTINAE *Pilsbry and Olsson*

Calliotectinae Pilsbry and Olsson 1954, Bull. American Paleontology **35**: 289.

This subfamily is characterized by Pilsbry and Olsson as having fusiform shells sculptured with recurved axial riblets. Columellar plicae weak or lacking. Operculum present. Radula of rachidian teeth each having three denticles in one plane.

The genus *Howellia* is the only member of this subfamily in the Western Atlantic. Nothing is known of the soft anatomy of its single species, *Howellia mirabilis* Clench and Aguayo. It was placed in this subfamily by Pilsbry and Olsson on the basis of its shell morphology.

We retain this subfamily on a provisional basis until we know much more about the soft anatomy. The type genus, *Calliotectum* Dall and its species *vernicosum* Dall, was dredged by the *Albatross* at Station 2793, off the coast of Ecuador in 741 fathoms and

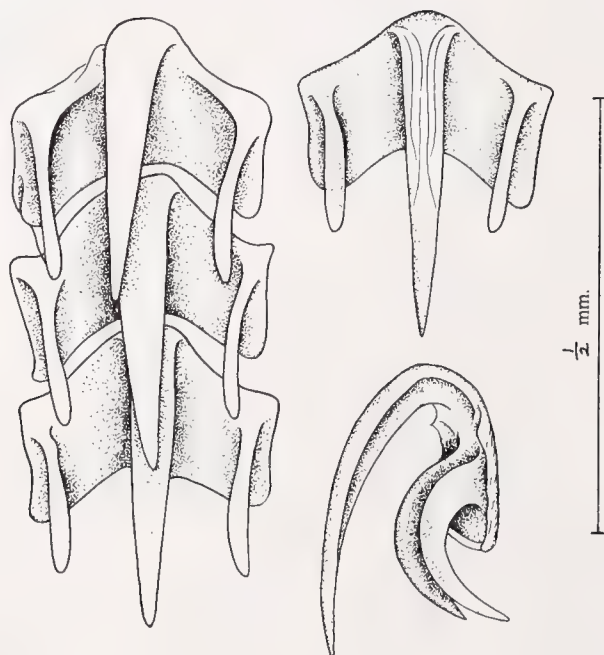


Plate 113. Radula of *Odontocymbiola americana* Reeve.

Station 2807, off the Galapagos Islands in 812 fathoms. Pilsbry and Olsson were able to obtain the radula and they figured a single tooth (1954, pl. 27, fig. 16). This is a simple type with the denticles in one plane and appears to be quite similar to the kind of radulae exhibited by various species in the Zidoninae. If other characters of the soft anatomy are eventually found to agree with those of the Zidoninae, Calliotectinae will become a synonym of the earlier Zidoninae.

Genus **Howellia** *Clench and Aguayo*

Howellia Clench and Aguayo 1941, *Memorias de la Sociedad Cubana de Historia Natural* **15**: 177.

Type species, *Howellia mirabilis* Clench and Aguayo, original designation.



Plate 114. *Howellia mirabilis* Clench and Aguayo. Off Matanzas, Cuba. Holotype (1.6x).

This is a monotypic genus, its characters are that of the type species.

Based upon shell morphology, this genus is exceedingly close to *Teramachia* Kuroda from Japan (1931, *Venus* 3: 45). Relationships of this sort from widely separated areas are unusual, but they do exist.

We are holding *Howellia* and *Teremachia* as different genera until the radulae can be examined.

***Howellia mirabilis* Clench and Aguayo**
Plate 114

Howellia mirabilis Clench and Aguayo 1941. *Memorias de la Sociedad Cubana de Historia Natural* 15: 177 (off Matanzas, Cuba (23°12' N; 81°23' W) in 285 fathoms). [Holotype, Mus. Comp. Zool., no. 135291.]

Description. Shell extended, reaching 93 mm. ($3\frac{3}{4}$ inches) in length, fusiform, rather solid, shining, imperforate and strongly sculptured. Color cream and tinged with a very faint brownish red. Whorls 10, convex and regularly increasing in size. Spire extended, acute and produced at an angle of about 27°. Aperture semicircular and colored a light brownish red within. Outer lip simple and slightly thickened. Parietal wall lightly glazed. Columella nearly straight. Suture impressed and crenulated. Sculpture consisting of sinuous, axial costae which disappear below the periphery. In addition, the first 5 whorls have numerous, fine, spiral, incised lines which disappear on the later whorls. Protoconch lost. Operculum unguiculate, corneous and with numerous, fine, parallel growth lines.

length	width	
93 mm.	28 mm.	Holotype

Remarks. This species is known from but a single specimen. Nothing, so far as now known, even approximates this genus and species in the Western Atlantic. As stated above, the generic relationship appears nearest to the genus *Teramachia* Kuroda from Japan.

* * * *

REFERENCES

- Barattini, L. P. and E. H. Ureta 1960. La Fauna de las Costas Uruguayas del Este, Montevideo, pp. 122-126.
- Bouvier, E. L. 1887. Système Nerveux des Gastéropodes Prosobranches. *Annales des Sciences Naturelles* 3: 1-510, 19 plates.
- Carcelles, Alberto 1944. Catalogo de los Moluscos Marinos de Puerto Quequén. *Revista Museo de La Plata* (n.s.) 3: 233-309.
- Carcelles, A. R. and S. I. Williamson 1951. Catalogo de los Moluscos Marinos de los Provincia Magallanica. *Revista del Instituto Nacional de Investigacion de las Ciencias Naturales, Zoology* 2: 225-383.
- Carriker, M. R. 1961. Comparative Functional Morphology of Boring Mechanisms in Gastropods. *Amer. Zool.* 1: 263-266.
- Clarke, A. H. 1962. Annotated List and Bibliography of the Abyssal Marine Molluscs of the World. *National Museum of Canada Bull.* 181: 27.

- Cooke, A. H. 1922. The Radula of the Volutidae. Proc. Malacological Soc. London **15**: 6-9.
- Corsi, A. F. 1900. Moluscos de la Republica Oriental del Uruguay. Anales del Museo Nacional de Montevideo **2**: 291-528.
- Cossmann, M. 1899. Essais Paléoconchologie Comparée, Paris **3**: 99-148.
- Dall, W. H. 1889. Reports on the Results of Dredging . . . in the Gulf of Mexico and in the Caribbean Sea by the U.S. Coast Survey Steamer "Blake" . . . Bull. Mus. Comp. Zool. **18**: 144-156.
- Dall, W. H. 1890. Contributions to the Tertiary Fauna of Florida. Trans. Wagner Free Institute of Science, Philadelphia **3**: 57-90.
- Dall, W. H. 1906. Notes on Some Names in the Volutidae. Nautilus **19**: 143.
- Dall, W. H. 1907. A Review of the American Volutidae. Smithsonian Misc. Collections **48**: 341-373.
- Dodge, Henry 1955. A Historical Review of the Mollusks of Linnaeus. Bull. American Mus. Nat. History **107**: 52-145.
- D'Orbigny, A. 1847. Voyage dans l'Amérique Méridionale, Paris **5**: 422-426.
- Feruglio, E. 1933. Terrazzi Marini della Patagonia. Annali del R. Museo Geologico di Bologna (2) **8** (bis): 1-288.
- Fischer, P. 1879. Note sur l'Animal du *Voluta musica* Linné. Jour. de Conchy. **27**: 97-106.
- Fischer, Paul 1884, Man. de Conchy., p. 609.
- Fischer-Piette, E. 1950. Liste des Types Décrits dans le Journal de Conchyliologie et Conservés dans la Collection de ce Journal. Jour. de Conchyl. **90**: 8-23; 65-82; 149-180; 310-333.
- Fluck, W. H. 1905. Shell Collecting on the Mosquito Coast of Nicaragua—II. Nautilus **19**: 17.
- Gray, J. E. 1858. [in] H. and A. Adams, The Genera of Recent Mollusca, London **2**: 615-620.
- Heilprin, Angelo 1887. Explorations on the West Coast of Florida. Trans. Wagner Free Institute of Science, Philadelphia **1**: 109.
- Krebs, H. 1864. The West-Indian Marine Shells with Some Remarks, Nykøbing, Denmark, pp. 1-137. Republished 1947-1948, Clench, Aguayo and Turner. Revista de la Sociedad Malacologica "Carlos de la Torre" **5**: 23-80, 91-116; **6**: 11-48.
- Kuroda, T. and T. Habe 1950. Illustrated Catalogue of Japanese Shells, no. 5, Volutidae, pp. 31-38.
- Lahille, F. 1895. Contribucion al Estudio de las Volutas Argentinas. Revista del Museo de La Plata **6**: 295-332.
- Melville, C. and R. Standen 1907. Scottish National Antarctic Expedition, Mollusca **5**: 89-127.
- Morrete, F. Lange de 1949. Ensaio de Catálogo dos Moluscos do Brasil. Arquivos do Museu Paranaense **7**: 5-216.
- Nicklès, M. 1950. Mollusques Testacés Marins de la Côte Occidentale d'Afrique, Paris, pp. 1-269, text figure 459.
- Ortmann, A. E. 1902. Princeton Univ. Expeditions to Patagonia, 1896-1899 **4**: pt. 2, pp. 226-235.
- Pace, S. 1902. On the Anatomy and Relationships of *Voluta musica* Linn.; with Notes upon Certain Other Supposed Members of the Volutidae. Proc. Malacological Soc. London **5**: 21-31.

- Pilsbry, H. A. and A. A. Olsson 1953. Materials for a Revision of the East Coast and Floridan Volutes. *Nautilus* **67**: 1-13.
- Pilsbry, H. A. and A. A. Olsson 1954. Systems in the Volutidae. *Bull. American Paleontology* **35**: 277-306.
- Sherborn, C. D. 1940. Where is the ——— Collection? Cambridge, England, pp. 1-148.
- Smith, Maxwell 1942. A review of the Volutidae, Lantana, Florida, pp. 1-127.
- Sowerby, G. B. 1845. *Thesaurus Conchyliorum, Volutidae* **1**: 191-220.
- Tryon, G. W. 1882. *Man. of Conchology* (1) **4**: 73-105.
- von Ihering, H. 1907. Mollusques Fossiles du Tertiaire et du Crétacé Supérieur de l'Argentine. *Anales Museo Nacional de Buenos Aires* (3) **7**: 201-212.
- Watson, R. B. 1886. Report on the Scaphopoda and Gasteropoda. *Voyage of H.M.S. Challenger* **15**: 253-264.
- Weaver, C. S. 1963. Provisional Species List of Living Volutidae, Honolulu, pp. 1-7.
- Wenz, W. 1943. *Handbuch der Paläozoologie* **6**: 1311-1355.
- Woodward, M. F. 1900. Note on the Anatomy of *Voluta ancilla* (Sol.), *Neptuneopsis gilchristi* (Sby.) and *Volutilithes abyssicola* (Ad. and Rve.). *Proc. Malacological Soc. London* **4**: 117-125.

* * * *

BOOK REVIEW

Fauna und Flora der Adria by Rupert Riedl 1963, Verlag Paul Parey, Hamburg and Berlin Publishers, 640 pages, 221 plates of line drawings, 8 colored plates.

This handbook on the flora and fauna of the Adriatic Sea fills a real need, for it is the first general book covering the area to appear in many years. It will be welcomed by all those interested in the marine life of the Mediterranean. The arrangement of the book is systematic, the first part (pp. 19-23 and pls. 3-23) is devoted to the plants, while the major portion (pp. 91-582, pls. 24-221) is devoted to the animals. The Introduction includes two plates which are in reality illustrated keys to the Phyla and Classes of animals. The Class name and page reference are given with each illustration so that the uninitiated can quickly find the proper place in the book. At the beginning of the sections covering each of the higher categories there is a brief discussion of the characters of the group, the methods of collecting and preserving peculiar to the group, and a brief bibliography. The plates are excellent line drawings or superb colored photographs of the species with their scientific names. The plate captions, which are also the text, briefly discuss the species and give the range and habitat of each. In the section on Mollusca (pp. 344-425, pls. 119-148) about 290 species are illustrated and the Opisthobranchia, a group usually neglected, are well covered. — R. D. TURNER

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PANDORIDAE

VOL. 4. NO. 44

THE FAMILY PANDORIDAE IN THE WESTERN ATLANTIC¹

BY

KENNETH J. BOSS² AND ARTHUR S. MERRILL³

The family Pandoridae, as represented by its single nominate genus, is cosmopolitan in distribution with a concentration of species in the cooler waters of the northern hemisphere. A number of species are boreal while a single one is circumpolar. The coasts of eastern Asia, western North America and eastern North America constitute the areas in which *Pandora* is most highly differentiated. Tropical and subtropical waters do not appear to suit most members of the genus and the group is therefore poorly represented in the faunas of Africa, South America and the Indo-Pacific.

Within species of the northern hemisphere, allopatric patterns of geographic speciation are evident, and from the known embryological evidence, localized populations seem to be maintained by the short-lived pelagic stage. One phenomenon resulting from geographic isolation and subsequent evolutionary divergence is the existence of species pairs. In this case the new and distinct species, having been derived from the same ancestral stem, possess many morphological traits in common. Barriers to the genetic introgression of such populations may be either intrinsic or extrinsic, and in the present state of malacological knowledge, the extrinsic mechanisms are better known and more easily deduced. The classic example includes the numerous paired species found separated by the Isthmus of Panama.

In *Pandora*, the fauna of the Western Atlantic is largely represented by analogous elements in the Eastern Pacific. Such a distinctive barrier as an isthmus need not always be evident. The Japanese species *wardiana* Adams is analogous to the Pacific North American *grandis* Dall. Both species are very similar morphologically but *wardiana* is distinguished by its unusually great size. Intraoceanic speciation in the littoral fauna may also be detected by similar allopatric patterns. In the Western Atlantic, *gouldiana* and *trilineata* exemplify this phenomenon and are analogous species. Gardner (1943) has noted that this specific distinction may be traced to the Miocene.

¹ Published with the aid of a Milton Grant.

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Contrary to Dall (1903) and Grant and Gale (1931), the fossil history of *Pandora* begins in the Tertiary not in the Cretaceous (Zittel, 1900). Stoliczka (1871) has confirmed this by asserting that no recognizable *Pandora* occur in Mesozoic deposits. In Europe, the genus has been found as early as the Eocene of the Paris Basin (Deshayes, 1860; Cossmann, 1886), and the fossil species *primaeva* Deshayes of these sediments is not unlike modern *glacialis*. The genus does not appear until the Miocene in North America; there do not seem to be any available Eocene records. The modern elements of the Western Atlantic fauna may be traced directly to the Miocene where numerous species had already developed.

ANATOMICAL NOTES

In *Pandora*, the thin transparent mantle is thickened ventrally and its lobes are united along its entire length except for the pedal and siphonal gapes. Along the edge of the mantle, the outer, middle and inner lobes may be most easily discerned at the pedal gape which extends from the anterior adductor muscle ventrally to a point just behind the base of the foot (pl. 115, 15). At this point the inner longitudinal muscular lobes of the mantle edge fuse; the fusion is complete to the incurrent siphon and not only a cuticular junction (Allen, 1954). In *Pandora gouldiana*, the incurrent siphon (pl. 115, 10) possesses two rows of papillae, the inner row generally with about 15–18, the outer row with about 18–20. The excurrent siphon (pl. 115, 9) has only a single row of papillae, numbering about 20 in *gouldiana* (Perkins, 1869; Morse, 1919). The siphons are

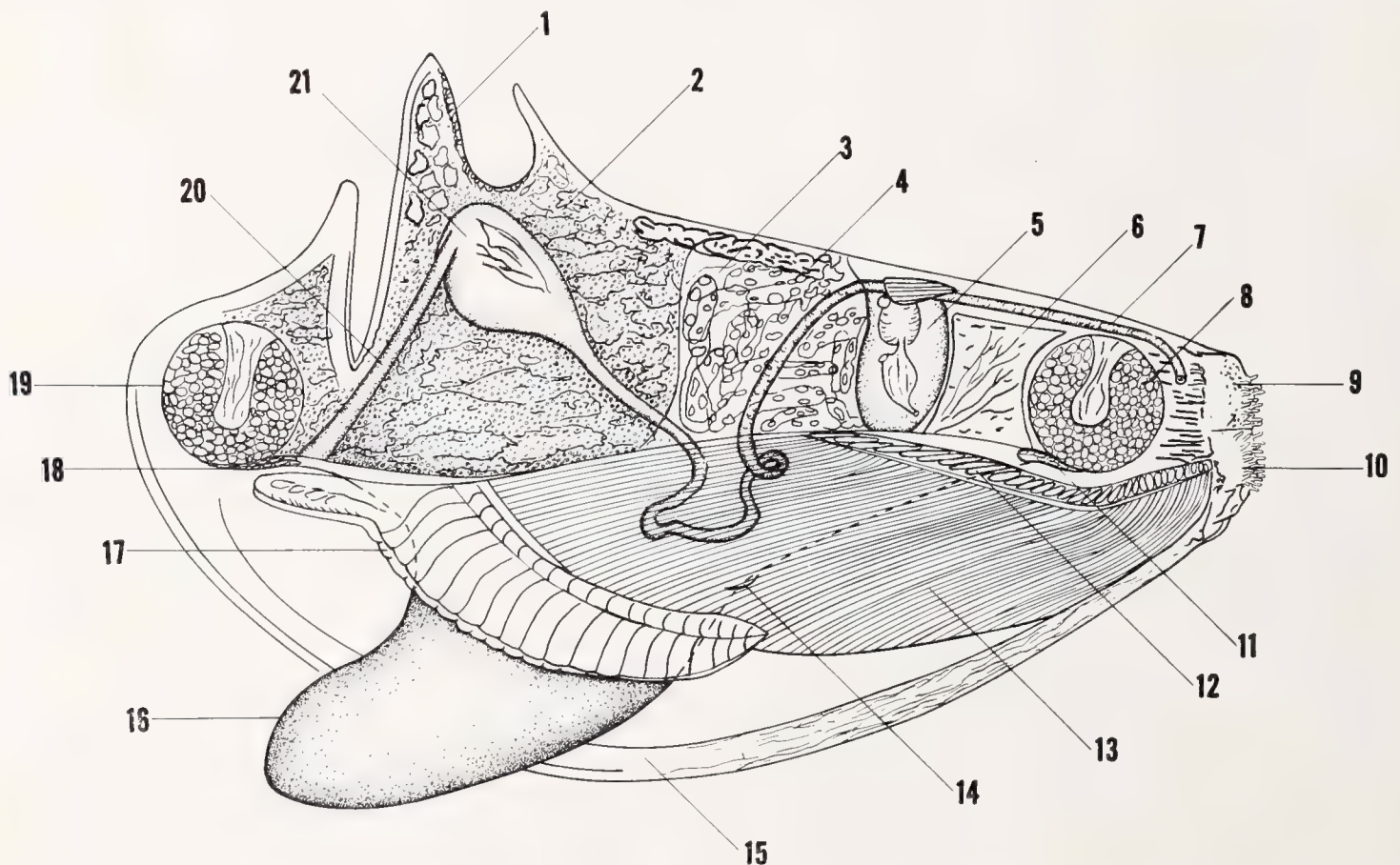


Plate 115. Diagram of the gross anatomy of *Pandora gouldiana* Dall, left valve and mantle removed.

1. Specialized cells to secrete resiliium and lithodesma. 2. Digestive diverticula. 3. Ovary. 4. Pericardial (Keber's) gland. 5. Heart. 6. Kidney. 7. Rectum. 8. Posterior adductor muscle with quick and catch muscle fibers. 9. Excurrent siphon with papillae. 10. Incurrent siphon with papillae. 11. Posterior pedal retractor. 12. Outer demibranch. 13. Inner demibranch. 14. Byssal gland and groove. 15. End of mantle union and beginning of pedal gape. 16. Foot. 17. Labial palps. 18. Anterior pedal retractor. 19. Anterior adductor muscle with quick and catch muscle fibers. 20. Esophagus. 21. Stomach.

short, united at their bases but separated by an internal intersiphonal septum. In *gouldiana*, the siphons are light brown in color, mottled with black dots. The muscular lobes of the mantle are thickened in this area to form the siphonal retractor muscles; nevertheless, the siphons are not capable of great extension and the animal in its burrowing habit is more or less limited to the epifaunal regions of the substrate.

The thickened muscle lobes of the mantle attach irregularly to the shell to form a discontinuous pallial line (pls. 117 and 118, 5). The anterior and posterior adductor muscles (pl. 115, 8 and 19) are subequal in size and are differentiated into "catch" and "quick" fibers. The anterior pedal retractor (pl. 115, 18) has its origin along the ventral surface of the anterior adductor muscle and inserts antero-dorsally in the foot. It is more extensive and better developed than the posterior pedal retractor (pl. 115, 11) which is small, thin and somewhat tendon-like. The latter muscle inserts into the foot postero-dorsally and has its origin at the base of the posterior adductor muscle. Both pedal retractors are unusual in that their origins are along the ventral border of the adductor muscles.

The mantle is completely united dorsally and there is a specialized area of cells beneath the umbo which function in the secretion of the resilium and the lithodesma (pl. 115, 1; and pls. 117–118, 8 and 9).

The laterally compressed foot (pl. 115, 16) is large, well developed and capable of considerable extension through the antero-ventral pedal gape. A byssal gland and groove (pl. 115, 14) are present but no byssus is developed in the adult stage although early post-larval *Pandora* may utilize byssal strands for attachment to the substrate (Allen, 1961).

As is characteristic of members of the Anatinacea, the gills of *Pandora* are separated into dorsally upturned outer and ventral inner demibranchs (Deshayes, 1848; Menegaux, 1890). The outer demibranch (pl. 115, 12) is small and very much reduced, consisting of only a single direct lamella (Pelseneer, 1911). The inner demibranch (pl. 115, 13), consisting of both internal and external lamellae, extends posteriorly nearly to the opening of the incurrent siphon where they are pendantly free and not attached to the siphonal septum as in *Anatina* (Burne, 1920). Just ventral and posterior to the foot at the nominal origin of the posterior pedal retractor muscle, the inner demibranch of the right and left sides unite. The remainder of the anterior portion of the demibranch is attached along its proximal margin to the body. The lamellae of *Pandora inaequalvis* Linnaeus are plicate and heterorhabdic with a specific number of filaments per plica (Ridewood, 1903). Atkins (1937) has described the ciliary currents, and Allen (1954) has figured the sorting mechanisms of the gill ciliation. The paired and bilobed labial palps (pl. 115, 17) are plicate and contiguous with the inner demibranch.

The mouth is situated at the anterior margin of the labial palps. In *Pandora gouldiana*, a relatively long esophagus (pl. 115, 20) leads to the stomach (pl. 115, 21) which possesses a developed gastric shield and crystalline style. Allen (1954) and Purchon (1958) have described in detail the structure and function of the stomach of *Pandora inaequalvis*. A large diffuse digestive diverticulum surrounds the stomach and connects with it by numerous ducts. The style-sac is combined with the midgut which extends postero-ventrally from the stomach, convolutes in the testicular tissue of the foot and arises abruptly to pass through the tubulous ovary and then through the pericardial wall to form the rectum. Continuing posteriorly out of the pericardium the rectum passes over the dorsum of the posterior adductor muscle and terminates with the anus in the excurrent siphonal cavity.

The structure of the nervous system of *Pandora* has been discussed by Duvernoy (1854). It is sufficient to mention that the cerebropleural ganglia are near the ventral surface of the anterior adductor muscle and are connected by a commissure. Long cerebro-visceral connectives extend posteriorly to the visceral ganglia at the base of the posterior adductor muscle, and separate cerebro-pedal connectives join the cerebropleural ganglia to the pedal ganglia. According to Pelseneer (1911), there are paired otoliths associated with the pedal ganglia.

The cardiac system of *Pandora* (see pl. 116) includes a large pericardium within which the paired auricles and ventricles are located and through which the rectum passes. The auricles attach to the pericardial wall near the kidneys and lead dorsally to the paired ventricles which lie below the alimentary canal. The ventricles then unite to form a common bulbus arteriosus which envelopes a portion of the rectum and which gives rise to the anterior and posterior aortae. Both the ventricle and auricle possess spheroidal structures the function of which is unknown. Dorso-lateral to the pericardium are the paired Keber's organs or pericardial glands.

As noted by Lacaze-Duthiers (1854), *Pandora* is monoecious with both male and female gonads occurring in a single individual. It appears that this hermaphroditic condition is typical of the Anatinacea. Arvy and Gaillard (1956) have noted that in *Pandora inaequalis* a parasitic cercarian, *Cercaria melanocystea*, destroys the gonad tissue, and replaces it with dark colored sporocysts. The nephridial system of *Pandora glacialis* has been considered by Odhner (1912), and pl. 117 illustrates the general structure of the reproductive and nephridial systems in *Pandora*. The ovary is more or less dorsal, tubular and superficial, occupying the central portion of the visceral mass. The testis is diffuse and consists of irregular glandular tissue buried deeply about the convolutions of the in-

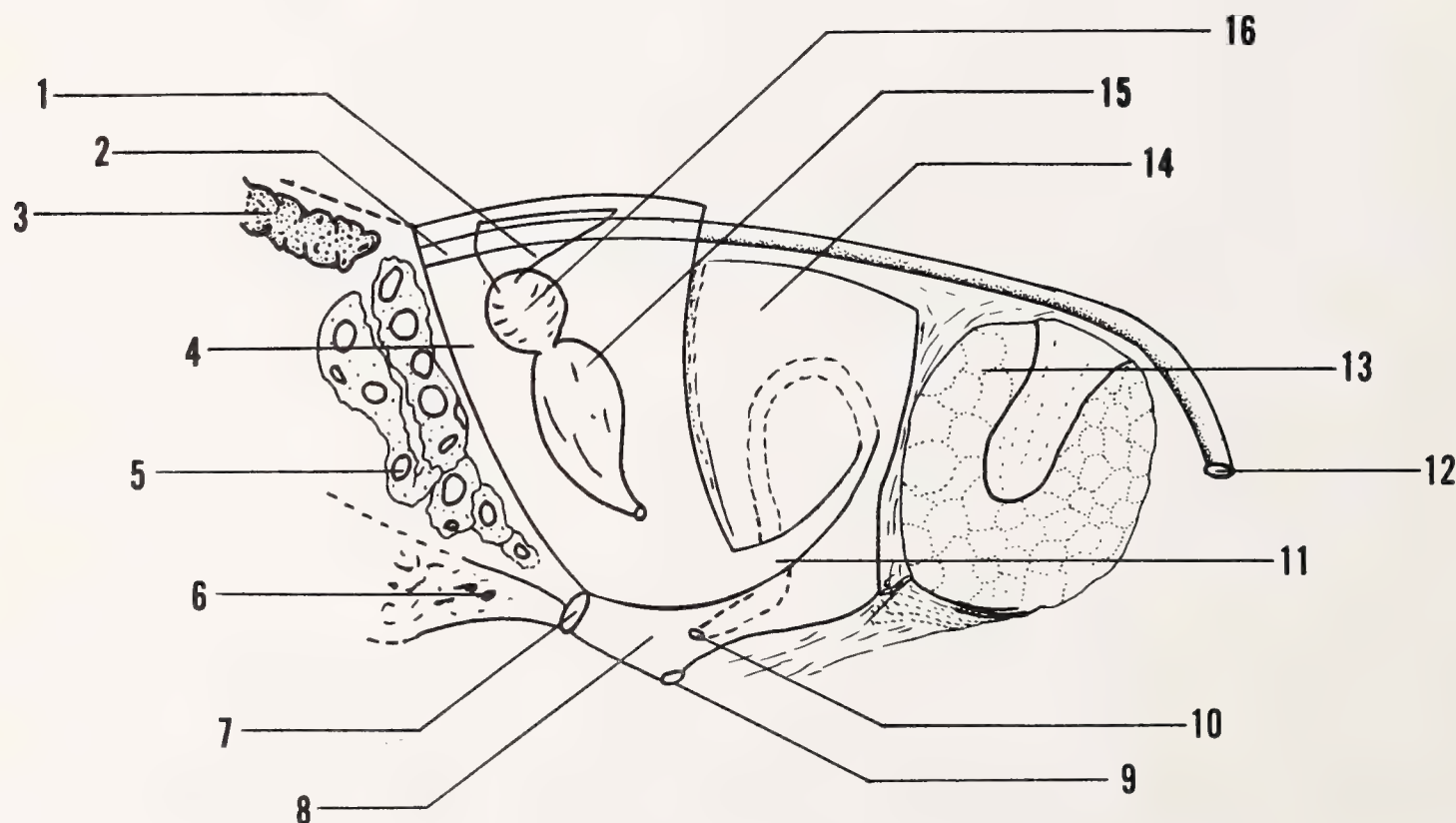


Plate 116. Diagram of the urogenital system of *Pandora*. 1. Bulbus arteriosus. 2. Rectum. 3. Pericardial gland (Keber's organ). 4. Pericardium. 5. Ovary. 6. Testis. 7. Common genital pore. 8. Urogenital canal. 9. Urogenital pore or orifice. 10. Nephroproct. 11. Reno-pericardial canal (Wimpertrichter). 12. Anus. 13. Posterior adductor muscle. 14. Kidney. 15. Auricle. 16. Ventricle.

testine in the dorsal mass of the foot. The testis and ovary open via a common genital pore into the urogenital canal. The kidney is located between the pericardium and the posterior adductor muscle. A ciliated reno-pericardial funnel or Wimpertrichter connects the cavity of the pericardium with the kidney. Thence the kidney leads via a renal orifice or nephroproct into the urogenital canal. Excretory wastes and reproductive products are thereby expelled into the suprabranchial chamber via a common urogenital orifice or pore.

Eggs in the ovary are already encapsulated and Pelseneer (1911) detected zygotes in early developmental stages within the gills and pallial cavity of *Pandora elongata* Carpenter. Burne (1920) reported eggs in the suprabranchial chamber of *Anatina*. Internal incubation appears to occur with some frequency within the Anatinacea.

The developmental biology of *Pandora inaequalis* has been discussed by Allen (1961). In that species, the eggs are quite large (105–125 μ in diameter) with considerable food reserves and similar lecithotrophic conditions also are found within *P. glacialis* Thorson (1936); Ockelmann (1958) and *P. gouldiana* (Perkins, 1869). Development appears to be rapid with metamorphosis occurring in less than four days. The larvae are generally released from the encapsulated eggs within 22 hours after fertilization and the veliger is short-lived, spending less than 24 hours in the plankton; dispersal, therefore, is somewhat minimized. In the settling stage of the dissoconch, attachment to the substrate is implemented by means of a byssus, and complete metamorphosis including the development of the labial palps, gills and foot is then completed. Allen's observations (1961) were experimentally derived, but they do not preclude the possible incubation of young as indicated by Pelseneer (1911). The time of spawning appears to vary from species to species. In *gouldiana*, it takes place in late spring or early summer, while in *glacialis* it occurs in late August (Ockelmann, 1958). We have seen eggs of *gouldiana* extended in mucus strands from the outer perimeter of the mantle. Presumably these mucus strands cling to the substrate until the eggs develop to a free-swimming stage. The eggs, obtained from specimens in Woods Hole, Massachusetts, measured between 130–140 μ .

SHELL MORPHOLOGY

The shell structure of *Pandora* has been discussed by Carpenter (1848). He described the shell of *Pandora inaequalis* as consisting of an internal nacreous and laminate layer and an external crystalline, prismatic layer. Between these layers is a so-called membranous partition. An organic periostracum covers the external portions of the shell and when this is worn away the underlying prismatic layer may be abraded revealing the internal aragonitic nacre. The abrasion of the prismatic layer appears to be common in such species as *Pandora gouldiana* and causes the external aspect of the shell to become a dull powdery white.

The ligament in *Pandora* consists of a number of portions. Posterior to the umbo and connecting the opposing valves, there is a thin ligamental sheath formed by a thickened periostracal covering. Along the anterior dorsal margin, another somewhat stronger sheath of ligamental tissue joins the valves; the attachment of this ligamental tissue is particularly evident in the left valve of *Pandorella* where a slight concavity is present along the anterior dorsal margin near the anterior cardinal tooth (pl. 119, 3). Internally a strong resilium is developed which consists of compressed layers of ligamental material.

In some subgenera, notably *Pandorella* and *Clidiophora*, a calcified supportive lithodesma subtending the resilium is developed.

The configuration of the dentition is somewhat complex in *Pandora*. It appears that quite recently some measure of morphological stability has been reached in the evolution of these structures. Dall (1903) recounted the numerous irregularities and the lack of stability in the fossil representatives of *Pandora* in the Miocene of North America. Even

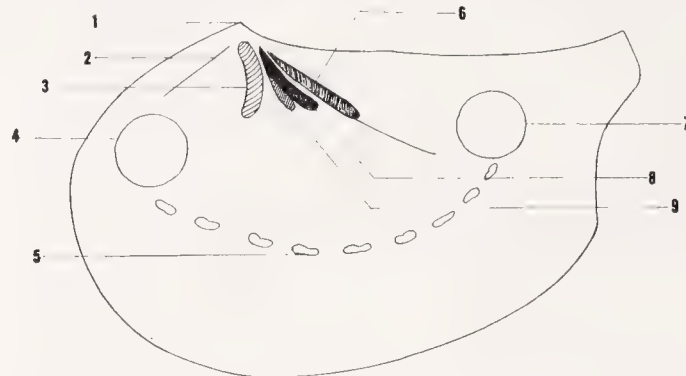


Plate 117. Diagram of the right valve of *Pandora gouldiana* Dall. 1. Umbo. 2. Anterior cardinal tooth. 3. Central pedunculate cardinal tooth. 4. Anterior adductor muscle scar. 5. Pallial muscle scar. 6. Posterior cardinal tooth. 7. Posterior adductor muscle scar. 8. Resilium. 9. Lithodesma.

in the recent species, particularly in such species as *Pandora gouldiana* Dall, variation of dental configuration is considerable. One of the simplest dental patterns is encountered in *Pandora inaequivalvis* Linnaeus, which has a well developed central pedunculate cardinal tooth in the right valve and poorly developed posterior and central teeth in the left.

For the purposes of uniformity and clarity, the following descriptive system will be utilized in discussion of the morphology of each species. The structural configuration upon which the discussion is based is taken from *Pandora gouldiana*, where a full complement of representative dental structures is present (pls. 117 and 118).

The dorsal internal hinge of the left valve possesses a number of unconformities — thickenings, protuberances and concavities. The anteriormost of these is called the anterior cardinal tooth. It may take the form of an elongate conspicuous internal ridge which is dorso-ventrally aligned (e.g., *gouldiana*, pls. 117 and 118, 2) or it may coalesce with the anterior dorsal margin to form a thickened structure along the hinge line and be aligned in an anterior-posterior direction (e.g., *glacialis*, pl. 119, 2). This tooth or its representative in a fusion with the hinge line is always evident to some degree. Its particular type of formation is a clue to subgeneric affinities in that *Clidiophora* possesses a

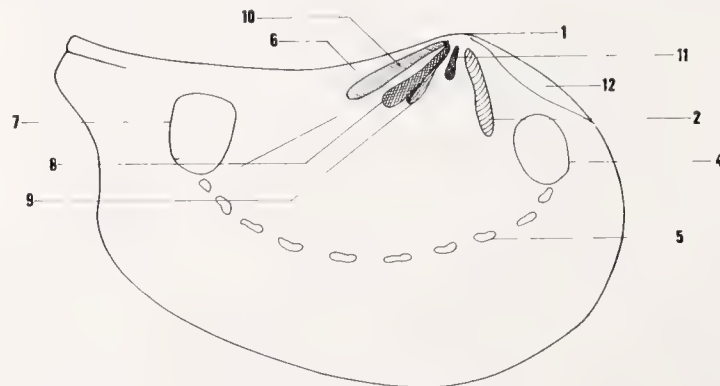


Plate 118. Diagram of the left valve of *Pandora gouldiana* Dall. 1. Umbo. 2. Anterior cardinal tooth. 4. Anterior adductor muscle scar. 5. Pallial muscle scar. 6. Posterior cardinal tooth. 7. Posterior adductor muscle scar. 8. Resilium. 9. Lithodesma. 10. Posterior fossa for the intrusion of the posterior cardinal tooth of the opposite valve. 11. Median cardinal tooth. 12. Anterior dorsal margin and ligamental concavity.

distinct anterior cardinal tooth parallel to the dorso-ventral axis of the shell, and *Pandorella* possesses a less distinct tooth, usually somewhat adpressed to the anterior dorsal margin and arranged in an anterior-posterior plane. The anterior terminus of this tooth presents a relationship to the anterior adductor muscle scar. In *Clidiophora*, the scar may or may not rest wholly beneath the terminus while in *Pandorella* the anterior adductor muscle scar is generally beneath the terminus or ventral border of the tooth.

Along the dorsal margin beneath the umbos is a deep cavity immediately behind the proximal terminus of the anterior cardinal tooth. The cavity or fossa receives the central, pedunculate cardinal tooth (pl. 117, 3) of the right valve when the valves are interlocked. A thin, raised central tooth (pl. 118, 11) separates the cavity for the pedunculate tooth from the resilial complex. The resilium (pl. 117, 8) rests upon an excavated surface, the posterior portions of which are slightly thickened and elevated to form the boundary of the posterior fossa or cavity (pl. 118, 10) which is the interlocking fixture for the posterior tooth of the right valve. Along the posterior dorsal margin of the valve, this fossa has a thickened ridge nominally referred to as the posterior cardinal tooth (pl. 118, 6), but in reality this is not a strong or well developed structure in *gouldiana*. Subtending the resilium is the calcareous lithodesma. In *Pandora claviculata*, the type of *Clidiophora*, there is a particularly well developed and elongate posterior lateral tooth which extends parallel to the posterior dorsal margin of the valve. In the subgenus *Foveadens*, as represented by *Pandora panamensis* Dall from the Eastern Pacific, there is a connective shelf which unites the long posterior lateral cardinal tooth with the posterior dorsal margin to form a hollow structure. While in other groups, notably the South Pacific *Coelodon*,

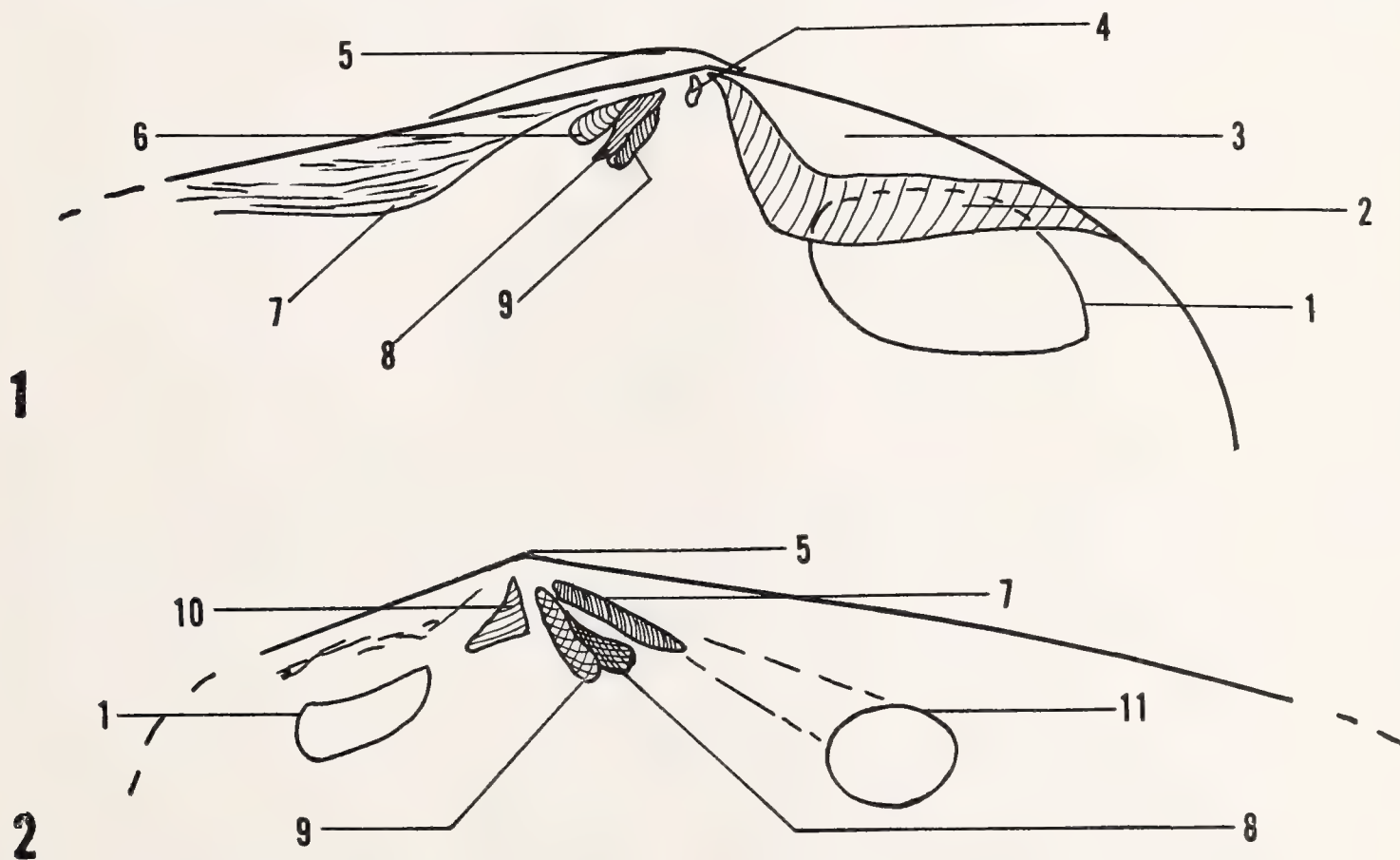


Plate 119. Diagrammatic enlargement of the hinge of *Pandora glacialis* Leach. Fig. 1. Internal view of the left valve. Fig. 2. Internal view of the right valve. 1. Anterior adductor muscle scar. 2. Anterior cardinal tooth. 3. Anterior dorsal margin and ligamental area. 4. Median cardinal tooth. 5. Umbo. 6. Posterior fossa for the intrusion of the posterior cardinal tooth of the right valve. 7. Posterior cardinal tooth. 8. Resilium. 9. Lithodesma. 10. Central pedunculate cardinal tooth. 11. Posterior adductor muscle scar.

as represented by *Pandora ceylanica* Sowerby, this tent-like connective structure occurs between the anterior and medial cardinal teeth.

The dentition of the right valve is characterized by an anterior cardinal tooth (pl. 117, 2) which radiates from the umbo to the dorsal margin of the anterior adductor muscle scar and which is defined by a radial fossa or sulcus which parallels it. In *Pandorella* and *Pandora* s.s. this cardinal tooth is so obscure that it usually is described as being absent, whereas in *Clidiophora* it is more highly developed and distinct and in *Coelodon* the tooth is strong and elevated. Medially there is a strong and central pedunculate cardinal tooth (pl. 117, 3) which is semilunate, subtrigonal, or diamond-shaped in cross section. This tooth appears to be developed in all species. Posterior to the pedunculate cardinal tooth is the resilium (pl. 117, 8) which rests on the excavated anterior under surface of the posterior cardinal tooth (pl. 117, 6). The calcareous lithodesma is attached to the ventral surface of the resilium. The posterior cardinal tooth is variously developed, ranging from a short stubby excrescence as seen in *P. inflata*, new name (= *brevis* Verrill & Bush) to the elongate thickened and strong structure in *P. gouldiana*. In *P. inaequalis*, the posterior tooth is obsolete and regarded as completely absent. It is not unusual for a thickened internal riblet to extend from the distal terminus of the posterior cardinal tooth toward the posterior adductor muscle scar.

The dentition is not as well developed in all species as it is in *gouldiana*. For example, in *inaequalis*, the left anterior cardinal tooth is somewhat hollowed beneath and buttressed with a ventral flange. The posterior fossa is not developed and no definite posterior tooth may be identified. In the right valve, the anterior cardinal tooth is obsolete, being represented by a feeble ridge, and no vestige of a posterior tooth is evident; only the central pedunculate cardinal tooth is strong and conspicuous. A lithodesma is lacking in *inaequalis* and in combination with the reduced dentition, these characters define the nominate subgenus.

ABBREVIATIONS

ANSP	Academy of Natural Sciences of Philadelphia
BCF	Bureau of Commercial Fisheries, Woods Hole, Massachusetts
BMNH	British Museum (Natural History), London
MCZ	Museum of Comparative Zoology
USNM	United States National Museum

The aforementioned abbreviations are used predominantly in the section under each species entitled "specimens examined." We have made a special note of those stations where living specimens were collected by the insertion of "(live)" following the station data. Where no comment is made, the specimens collected were dead.

SYSTEMATIC TREATMENT

Superfamily ANATINACEA

Family PANDORIDAE Gray 1847

Description. Shell of small to moderate size, not exceeding 60 mm. in length, crescent-shaped, more or less compressed, inequilateral with the anterior portion short and the posterior long and often rostrate, inequivalve with the left valve usually the more convex and larger and the right valve flattened or somewhat concave. Umbo generally elevated,

pointed and often corroded. Hinge complex, with subexternal ligamental portions and an internal resilium, which is sometimes supported by a calcareous lithodesma. Hinge dentition variable but generally the right valve possesses a large pedunculate, central cardinal tooth while the left valve possesses anterior and/or posterior cardinal teeth. Shell generally whitish; external prismatic layer rather easily corroded; internal layer nacreous.

***Pandora* Bruguière 1797**

Pandora Bruguière 1797, Encyclopédie Méthodique, Vers Testacés 2: pl. 250, figs. 1a–c; Lamarck 1799, Mem. Soc. Hist. Nat. Paris, an. vii, p. 88 (type species by subsequent monotypy, Lamarck 1799, *Tellina inaequalis* (Linnaeus) 1758), *non* Mühlfeld 1811 (Mollusca), *nec* Eschscholtz 1829 (Ctenophora), *nec* Haliday 1833 (Diptera), *nec* Chevrolat 1834 (Coleoptera), *nec* Westwood 1848 (Lepidoptera), *nec* Koch 1850 (Arachnida), *nec* Sars 1895 (Crustacea).

Calopodium Röding 1798, Museum Boltenianum, 1st Ed., p. 166; 1819, *Ibid.*, 2nd Ed., p. 116 (type species by monotypy, *Calopodium albidum* Röding [= *Tellina inaequalis* (Linnaeus) 1758]).

Trutina Brown 1827, Illustrations of the Conchology of Great Britain and Ireland, 1st Ed., pl. 13, fig. 5; 1844; *Ibid.*, 2nd Ed., p. 104, pl. 47, figs. 5, 12 and 13 (type species by monotypy, *Trutina solenoidea* Brown [= *Solen pinna* Montagu 1803 (= *Tellina inaequalis* (Linnaeus) 1758)]).

Pandorina Scacchi 1836, Catalogus conchyliorum regni neapolitani, p. 6, *non* Scacchi 1833 (Mollusca), *nec* Bory de St. Vincent 1827 (Protozoa).

The generic name *Pandora* possesses a complex nomenclatorial history and it is hoped that the present treatment may settle some of the discrepancies of the past as well as rule out the possible usage of any junior synonyms. The name originated with Hwass and its introduction dates from Chemnitz (1795) who remarked:

Der Herr Justissrath Hwass hat aus solchen Tellinen, die oben einen flachen Deckel und unten eine tiefe Unterschale haben, wie *Tellina inaequalis*, *crystallina* und andere, ein neu Geschlecht errichtet und es *Pandora* genannt.

Some controversy concerning the appropriate generic name was interjected into the the literature by Prashad (1932) and Winckworth (1934). In 1944, the International Commission of Zoological Nomenclature published Opinion 184 which had the effect of sanctioning the generic names of Chemnitz which occurred in the nonbinomial volumes of the Conchylien-Cabinet. Various authors thereby quoted “*Pandora* Hwass [in] Chemnitz” or merely “*Pandora* Chemnitz” (Hertlein and Strong, 1946; Keen, 1958; Palmer, 1958; Olsson, 1961). Opinion 184 was reversed with the decision to place the first eleven volumes of the first edition of the Neues Systematisches Conchylien-Cabinet of Martini-Chemnitz on the official index of rejected literature. This action rendered *Pandora* Chemnitz unavailable.

Prashad (1932) recognized that the name *Calopodium* Röding 1798 was introduced before Lamarck’s usage of *Pandora*. Numerous workers were aware that Bruguière had included *Pandora* without a trivial name in a plate caption in the Encyclopédie Méthodique. For plate 250 of volume 2 of the plates, Sherborn and Woodward (1906) have established the correct date as 1797. Stewart (1930) employed Bruguière’s name and, notwithstanding the evidence marshalled by Dodge (1947), the generic name *Pandora* Bruguière 1797 is valid and available according to the International Code of Zoological Nomenclature (1961) (15th Congress), Art. 11 (c) (i) and Art. 16 (a) (vii).¹

¹ Winckworth (1934) would no doubt have given the same interpretation but was held to Opinion 1 (1907) which eliminates names based on plate captions.

The questions concerning type species and type designations for the genus have been variously interpreted (Palmer, 1958). There are actually numerous subsequent and different type designations for the genus (Schmidt, 1818; Children, 1823; Gray, 1847; Stoliczka, 1871; Kobelt, 1878; Dall, 1903). Lamarck (1799) was the first to use *Pandora* with a specific epithet and an interpretation of the Code shows that *Tellina inaequivalvis* Linnaeus becomes the type species by subsequent monotypy [Art. 68 (a) (ii) (2)].

Röding (1798) introduced *Calopodium* with the single species *albidum*, under which *Tellina inaequivalvis* Linnaeus was given as the only reference. Therefore, *Calopodium albidum* is a junior synonym of *Tellina inaequivalvis* and the generic name *Calopodium* is absolutely synonymous with *Pandora*.

Subgenus **Clidiophora** Carpenter

Clidiophora Carpenter 1864, Proc. Zool. Soc. London, p. 576 (type species, by original designation, *Clidiophora claviculata* Carpenter 1855 [= *Pandora arcuata* Sowerby 1830]).

Clidiophora 'Carpenter' Johnson 1934, Proc. Boston Soc. Nat. Hist. 40 (1): 31, error for *Clidiophora* Carpenter.

According to Dall (1903), *Clidiophora* is characterized by three teeth in the left valve, the posterior of which is much elongated and by three teeth in the right valve, the anterior of which is weak. A lithodesma, subtending the internal resilium, is present.

Clidiophora is represented by three species in the Western Atlantic. The type of the subgenus is found in the Eastern Pacific and possesses an unusually elongate posterior cardinal tooth in the left valve. None of the Western Atlantic species possesses such a highly developed right posterior cardinal tooth. The diagnostic traits which separate this subgenus from *Pandorella* include the nature of the left and right anterior cardinal teeth. In the right valve, the anterior cardinal tooth is weak and obsolete, but nevertheless a definitive structure may be discerned extending from the umbonal area to the dorsal margin of the anterior adductor muscle scar. The right posterior cardinal tooth is somewhat diagnostic since it is more elongate and stronger than the homologous structure in *Pandorella*. Most important, and perhaps the most easily detected, diagnostic trait is the left anterior cardinal tooth which extends more or less perpendicularly to the antero-posterior axis of the shell (that is, it is more or less parallel to the dorso-ventral axis). In *Pandorella* this structure is not aligned in a dorso-ventral direction. In *Pandora s.s.* the tooth is coalesced with the anterior dorsal margin and a lithodesma is absent (see pls. 118 and 119, 1).

Pandora (Clidiophora) gouldiana Dall

Plate 120, figs. 3-4; Plate 121, fig. 4; Plate 122, figs. 5-6

Pandora trilineata 'Say' Conrad 1831, Amer. Marine Conch., p. 49, pl. 11, figs. 1-2; Russell 1839, Jour. Essex County Nat. Hist. Soc. 1(2): 54; Gould 1841, Invert. Mass., 1st Ed., p. 44; DeKay 1843, Nat. Hist. N.Y. 5: 239, pl. 33, figs. 310 a-b; Mighels 1843, Boston Jour. Nat. Hist. 4: 314; Stimpson 1851, Shells New England, p. 23; Binney 1870 [in] Gould, Invert. Mass., 2nd Ed., p. 62, fig. 379; Perkins 1869, Proc. Boston Soc. Nat. Hist. 13: 143; Tryon 1874, Amer. Marine Conch., p. 136, pl. 18, figs. 305-7; Apgar 1891, Jour. New Jersey Nat. Hist. Soc. 2(2): 108; Morse 1919, Proc. Boston Soc. Nat. Hist. 35(5): 160-1, fig. 17, non Say 1822.

Pandora (Clidiophora) gouldiana Dall 1886, Bull. Mus. Comp. Zool. 12: 312; 1889, Bull. 37, United States Nat. Mus., p. 68, pl. 59, fig. 14; 1902, Proc. United States Nat. Mus. 24: 511, pl. 32, fig. 7 (type locality, Woods Hole, Mass.; holotype, USNM 95490).¹

Pandora (Clidiophora) gouldiana Dall, Johnson 1934. Proc. Boston Soc. Nat. Hist. 40(1): 31, error for *Clidiophora* Carpenter.



Plate 120. Figs. 1 and 2. *Clidiophora inornata* Verrill and Bush 1898 [= *Pandora (Clidiophora) inornata*]. USNM 49760, *Speedwell*, Station 327, off Cape Cod, south end of Stellwagen Bank, in 17 fathoms. Fig. 1. External view of the left valve of a syntype (4.7x). Fig. 2. External view of the right valve of a syntype (4.7x). Figs. 3 and 4. *Pandora (Clidiophora) gouldiana* Dall 1886. USNM 95490, Woods Hole, Massachusetts. Fig. 3. External view of the left valve of the holotype (2.6x). Fig. 4. External view of the right valve of the holotype (about 2.4x).

Description. Shell extending to 35 mm. in length (about $1\frac{1}{2}$ inches) and to 27 mm. in height (about 1 inch), somewhat compressed, thin or subsolid to solid in large adults, inequilateral, inequivalve with the left valve of a weak convexity and with the right valve more or less flattened but often centrally a little convex and weakly swollen. Umbos in the anterior third of the shell, elevated, pointed and conspicuous. Anterior margin somewhat broadly rounded and distinctly separated from the ventral margin at the terminus of the anterior radial sulcus; ventral margin convex, rising behind and slightly indented beneath the rostrum; anterior dorsal margin straight to convex, smoothly confluent with the anterior margin in adults but generally well differentiated in youthful stages; posterior dorsal margin long, concave and rising posteriorly to form a rostrum; posterior margin very short and more or less oblique to the dorso-ventral axis of the shell. In the left valve, there is at least one strong posterior radial ridge extending from the umbo to the base of the posterior margin and usually another more dorsal ridge is found with a

¹Dall noted that what numerous New England authors had been calling *trilineata* Say was truly a species hitherto undescribed and that true *trilineata* Say was a form with a more southerly range. Dall very briefly described *gouldiana* in a footnote in the *Blake* report and then later figured it.

sulcus between the ridges; these ridges generally define the rostrum. An anterior radial sulcus extends in a nearly straight line, dorso-ventral fashion from the umbo to the place where the ventral margin and the anterior margin are confluent; this sulcus sharply delimits the two margins. In the right valve a weak posterior radial sulcus extends from the umbo to the base of the posterior margin just ventral to the posterior dorsal margin. Concentric sculpture evident on the left valve as irregular, coarse undulations. Radial lines may be evident on the right valve. Hinge generally stout, strong and well developed; resilium with a lithodesma. In the left valve, the anterior cardinal tooth dorso-ventrally straight to arcuate, separate from the anterior dorsal margin; central tooth short, small and obsolete; resilium long, resting in a depression which is thickened along its sides; posterior cardinal tooth consists of a mere thickening of the hinge line. In the right valve, the posterior cardinal tooth is strong, acutely subtrigonal, and the resilium rests in a fossa along its anterior surface; central pedunculate tooth elongate to subulate; anterior tooth more or less obsolete and weak, grooved behind and extending from the umbonal region directly to the dorsal boundary of the anterior adductor muscle scar. Muscle scars rounded and well impressed. Pallial sinus consisting of small individual scars extending between the anterior and posterior adductor muscle scars. Color white, powdery to shining externally, nacreous internally.

length	height	width	
28.5 mm.	19.5 mm.	4.0 mm.	Holotype of <i>gouldiana</i> Dall
34.3	21.4	5.8	Duxbury, Mass.
32.6	22.0	7.0	Harpswell Island, Maine
32.3	26.1	6.6	off Wellfleet, Massachusetts Bay
29.0	18.4	5.2	Winthrop, Mass.
27.4	16.9	4.5	Woods Hole, Mass.
22.7	13.3	2.6	“ “ “
18.9	12.4	2.4	off Block Island, Mass.
15.3	8.5	2.0	“ “ “ “
9.4	4.7	1.1	Long Island, New York

Remarks. *Pandora gouldiana* appears to be one of the most common *Pandora* of the Western Atlantic and it is often encountered as a conspicuous element in the littoral fauna of New England. It has been recorded in numerous faunal lists and some literature concerning its natural history is available. Early New England authors confused this northern species with the slender and elongate allopatric southern species *Pandora trilineata* Say. The latter is distinctly the closest ally of *gouldiana* and as Jacot (1921) and Richards (1936) have indicated, there is some doubt about the specific identity of each. The primary distinguishing trait which separates *gouldiana* from *trilineata* is in the proportion of the shell. The length-height ratio in *trilineata* is greater than it is in *gouldiana*; that is, *trilineata* is more elongate and narrow whereas *gouldiana* tends to be more quadriform or subrectangular. The posterior rostrum in *trilineata* is therefore more conspicuous and distinct while in *gouldiana* the rostrum is short, tending toward bluntness. The height of the valve just anterior to the beginning of the rostrum is greater in *gouldiana* and, in point of fact, the ventral margin tends to be convex and expanded in this region. On the contrary, *trilineata*, is narrowed posteriorly, the ventral margin rising more abruptly and the shell height contracted. It may be said that *gouldiana* is coarsely sculptured with undulations in the left valve and that the shell appears to be thicker and heavier than its southern counterpart which has been called the “elegant,

slender" species. *Pandora gouldiana* and *trilineata* appear to be allopatric but in contradiction to Dall (1903), *trilineata* does range north of Cape Hatteras and has been represented in numerous samples taken in Chesapeake Bay.

Another close relative of *gouldiana* is the sympatric species *inornata*, which lacks the definitive posterior radial ridges. A full account of the differences separating *gouldiana* and *inornata* is given under 'Remarks' in *inornata*.

The range of variation exhibited by *gouldiana* is particularly important in regard to dental configuration. The anterior laminate cardinal tooth of the left valve is normally perpendicular or in alignment with the dorso-ventral axis of the shell and further it is generally widely separated from the anterior dorsal margin; however, in some individuals such a configuration does not always obtain and this cardinal tooth may become arcuate and extend quite close to the anterior dorsal margin, although always being distinctly separated from it. The terminus of the tooth may or may not be contiguous with the dorsal aspect of the anterior adductor muscle scar. Such conditions point out more than the relative instability of dental morphology in a single species; they show that the rudiments of subgeneric classification rest upon weak fundamentals and that the subgeneric taxonomy of the whole family becomes open to circumspection.

The questionable value of subgeneric traits is further made apparent when the radial lines on the external surface of the right valve are considered. These structures in *gouldiana* link it, as a member of *Clidiophora*, with *Pandorella* (= *Kennerlia*). The dental structure of *Clidiophora*, as exhibited by *gouldiana*, is slightly more complex in being thickened and more heavily expressed, but fundamentally quite similar to that of *Pandorella*.

According to Perkins (1869), *gouldiana* is abundant in muddy substrates at shallow depths in Long Island Sound. Apgar (1891) recorded the species along the coast of New Jersey where it was found in sand and mud; and Sumner, Osburn and Cole (1913) charted its occurrence and listed it as one of the commonest mollusks in Buzzards Bay and Vineyard Sound. In the Woods Hole vicinity, specimens were found living in from 3 to 19 fathoms, predominantly in mud, sand or muddy-sand substrates, although it was mentioned that specimens were sometimes found on gravelly substrates. We have taken *gouldiana* in considerable numbers on the pebbly bottom off Block Island, and at numerous stations along the middle Atlantic in a variety of bottom substrates. A tabulation of specimens obtained in the living state shows that the species may be found in depths down to 100 fathoms. Gould (1841) mentioned that it is often encountered nestling among and upon oysters.

Perkins (1869) and Morse (1919) have discussed briefly some aspects of the anatomy of *gouldiana*. The former mentions that the individuals are filled with ova in April and May; and Sullivan (1948), who unfortunately could not observe the larva, showed that the prodissoconch is very long in proportion to its height. Observations on the eggs of *gouldiana* have been given earlier (see page 185). The species is hermaphroditic and spawning occurs in late spring or early summer. The trochophore and veliger periods are probably short (Allen, 1961). For a discussion of the gross morphology of this species, see the anatomical notes (pl. 115).

The fossil history of *gouldiana* is extensive. An immediate precursor which is found in the Miocene is *Pandora crassidens* Conrad with its contemporaneous related forms *Pandora crassidens majorina* Gardner and *Pandora prodromos* Gardner and Aldrich. Gardner (1943) has given a thorough discussion of the morphological interrelationships

among these fossils, all of which may be construed as belonging to the lineage of the modern species *gouldiana*. From the Pliocene of Florida, Olsson and Harbison (1953) have identified *crassidens*, and from the Pleistocene, Blake (1953) and Richards (1962) have listed localities in Massachusetts, New Jersey, and Maryland for *gouldiana*.

Range. This species has been found in Canadian waters as far north as Gaspé, Quebec and is commonly encountered southward along the Atlantic coast to Cape Hatteras, North Carolina in depths to 100 fathoms.

Specimens examined. QUEBEC: Gaspé (USNM). NEW BRUNSWICK: Escuminac Point; Sand Island (both USNM). PRINCE EDWARD ISLAND: Malpeque Bay (live) (MCZ); Cape Egmont (live) (USNM). CAPE BRETON ISLAND: Eastern Harbour, Cheticamp, in 2–4 fathoms (USNM). NOVA SCOTIA: Macoun, in 5–13 fathoms (USNM); Banquereau Bank, in 80 fathoms (live) (MCZ); Digby (USNM). MAINE: St. Croix River (MCZ); Frenchman's Bay (live) (MCZ); Blue Hill Bay; Penobscot Bay; Bakers Island, in 20 fathoms (live) (all USNM); North Haven (live) (MCZ); west side of Harpswell Island (USNM); Eastern Point, west side of Chebeague Island (live); High Pine Ledge (live) (both MCZ); *Bache*, Station 42B, 6 miles SE of Boon Island ($43^{\circ}05' N$; $70^{\circ}28' W$), in 68 fathoms (live) (USNM). MASSACHUSETTS: Tillies Bank, in 78 fathoms (live); Marblehead (live); Swampscott (all MCZ); Winthrop; Chelsea (both USNM); Stellwagen Bank (live); Garnet Ledge, Duxbury (live) (both MCZ); Eastham (live) (MCZ); Cape Cod Bay, 8 miles off Wellfleet, in 15 fathoms (live); Truro (both USNM); Provincetown (live); Dennisport (live); Poponesset Beach, Mashpee (live) (all MCZ); Woods Hole (live); *Fish Hawk*, Station 1211, north end of Woods Hole, in $6-8\frac{1}{2}$ fathoms; off North Falmouth, in 6 fathoms (live) (all USNM); *Asterias*, Station E, Buzzards Bay (live) (BCF); New Bedford; *Blake*, Station 308, 200 miles E of Cape Cod ($41^{\circ}24' N$; $65^{\circ}35' W$), in 1242 fathoms (both USNM); *Albatross III*, cruise 101, Station 89, central Georges Bank ($41^{\circ}29' N$; $67^{\circ}28' W$), in 23 fathoms (BCF); East Georges Bank ($41^{\circ}20' N$; $66^{\circ}50' W$), in 37 fathoms (in fish stomach) (MCZ); *Fish Hawk*, Station 1240, SSE of Gayhead Light, in $18\frac{1}{2}$ fathoms (USNM); off Gay Head, in 75–100 fathoms (live) (MCZ); *Albatross III*, cruise 70, Station 4, 60 miles E of Nantucket ($41^{\circ}06' N$; $68^{\circ}38' W$), in 26 fathoms; *Albatross III*, cruise 70, 17 miles SE of Nantucket ($41^{\circ}01' N$; $69^{\circ}42' W$), in 20 fathoms (both BCF). RHODE ISLAND: Tiverton; Sakonett River, 6 miles S of Tiverton, in 2–3 fathoms (live) (both MCZ); *Fish Hawk*, Stations 786 and 787, off Newport, in 19 fathoms (live) (USNM); Watch Hill; off Block Island (live) (both MCZ); *Delaware*, cruise 62-7, Station 62, 12 miles SE of Block Island ($41^{\circ}01' N$; $71^{\circ}19' W$), in 29 fathoms (live, with eggs, June 19, 1962); *Delaware*, cruise 62-7, Station 64, 14 miles S of Block Island ($41^{\circ}00' N$; $71^{\circ}30' W$), in 30 fathoms (both BCF). CONNECTICUT: Long Island Sound, off Stonington (live); off Fishers Island, 6 miles S of New London (live) (both MCZ); *Bluelight*, Station 423, Fishers Island Sound, in 17 fathoms; *Fish Hawk*, Station 1624, 3 miles S of Bridgeport, in 5 fathoms (live) both USNM). NEW YORK: Peconic Bay, Long Island (USNM); *Delaware*, Station 2-1, alt. tow 53, 7 miles SE of Montauk Point, Long Island ($40^{\circ}58' N$; $71^{\circ}44' W$), in 26 fathoms (live); Northport, Long Island (both MCZ); Hempstead Harbor, Long Island (USNM); Coney Island; *Delaware*, Station 3-2, alt. tow 38, 19 miles SE of Moriches Inlet ($39^{\circ}49' N$; $72^{\circ}57' W$), in 36 fathoms (live) (both MCZ). NEW JERSEY:

Delaware, Station 3-2, alt. tow 33, 40 miles E of Barnegat Inlet (39°39' N; 73°12' W), in 22 fathoms (live); *Delaware*, Station 3, tow 3, 65 miles E of Atlantic City (39°08' N; 73°08' W), in 40 fathoms (all MCZ); Cape May (USNM); *Delaware*, Station 4-3, alt. tow 27, 75 miles E of Cape May (38°52' N; 73°23' W), in 36 fathoms (live) (MCZ). DELAWARE: Lower Middle Shoal, Delaware Bay, in 3 fathoms (live); off Lewes, in 3½ fathoms (live) (both USNM); *Delaware*, Station 4-3, alt. tow 24, 69 miles E of Indian River Inlet, (38°32' N; 73°31' W), in 46 fathoms (live) (MCZ). MARYLAND: *Delaware*, Station 4-5, alt. tow 1, 47 miles E of Ocean City (38°04' N; 74°06' W), in 41 fathoms (live) (MCZ). VIRGINIA: *Delaware*, Station 5-4, alt. tow 20, 48 miles E of Assateague Cove (37°50' N; 74°23' W), in 35 fathoms (live); *Delaware*, Station 5, tow 3, 49 miles E of Metomkin Inlet (37°39' N; 74°23' W), in 40 fathoms (live); *Delaware*, Station 6-5, alt. tow 17, 56 miles E of Cape Charles (37°05' N; 74°48' W), in 34 fathoms (live); *Delaware*, Station 6, tow 3, 60 miles E of Cape Henry (36°51' N; 74°45' W), in 40 fathoms (live); *Delaware*, Station 6-7, alt. tow 5, 53 miles E of False Cape (36°44' N; 74°48' W), in 35 fathoms (all MCZ). NORTH CAROLINA: *Delaware*, Station 8-7, alt. tow 11, 23 miles E of Bodie Island (35°59' N; 75°04' W), in 18 fathoms (live); *Delaware*, Station 7-8, alt. tow 8, 31 miles E of Bodie Island (35°54' N; 74°55' W), in 36 fathoms (live) (both MCZ).

***Pandora (Clidiophora) trilineata* Say**

Plate 121, figs. 1-3

Pandora trilineata Say 1822, Jour. Acad. Nat. Sci. Philadelphia, 1st Ser., 2: 261; 1830, American Conchology, pl. 2 (Great Egg Harbor, New Jersey; types not seen, not in ANSP).

Pandora nasuta Sowerby 1830, Species Conchyliorum, *Pandora*, pl. 1, figs. 18, 19 (locality unknown; types not seen).

Clidiophora trilineata Say. Carpenter 1864, Proc. Zool. Soc. London, p. 597.

Clidiophora nasuta Sowerby. Carpenter 1864, Proc. Zool. Soc. London, p. 597.

Pandora (Clidiophora) trilineata Say. Dall 1886, Bull. Mus. Comp. Zool. 12: 311.

Pandora (Clidiophora) floridana Dall 1886, Bull. Mus. Comp. Zool. 12: 312 [*nomen nudum*].

Pandora (Clidiophora) trilineata Say. Johnson 1934, Proc. Boston Soc. Nat. Hist. 40(1): 31, error for *Clidiophora* Carpenter.

Description. Shell extending to 30 mm. in length (about 1¼ inches) and to 14 mm. in height (about ⅝ inch), somewhat compressed, subsolid, inequilateral, inequivalve with the left valve overlapping the right ventrally, but both valves are weakly convex. Umbos in the anterior fourth or fifth of the valve, elevated, pointed and conspicuous. Anterior margin broadly convex, markedly distinguished from the ventral margin at the anterior radial sulcus; ventral margin smoothly rounded, convex, rising behind, slightly indented and contracted beneath the rostrum. Anterior dorsal margin short, straight to concave, generally not smoothly confluent with the anterior margin in young individuals; posterior dorsal margin elongate, concave and arcuate; posterior margin very short, forming the pointed terminus of the rostrum. In the left valve, two strong radial ridges with an intermediate sulcus extending from the umbo posteriorly; these ridges define the rostrum behind; an anterior radial sulcus extends in a dorso-ventral arcuation and delimits ventrally the confluence of the anterior and ventral margins. In the right valve, two radial and concomitant sulci extend posteriorly from the umbo; anterior radial sulcus arcuate and more or less obscure. Concentric sculpture consisting of irregular and

weak lirations; the valves generally appear to be smooth. Hinge with an internal resilium and lithodesma. In the left valve, the dentition consists of an anterior lateral tooth which is strong and extends parallel to the dorso-ventral axis, of a weak rib-like central tooth and of an obsolete posterior tooth. In the right valve, the dentition consists of an obsolete straight anterior ridge-like tooth, a central thickened pedunculate tooth and a long thin posterior tooth on the under surface of which rests the resilium. Adductor muscle scars rather large, rounded and well impressed. Pallial sinus consists of irregular individual scars extending between the anterior adductor and posterior adductor muscle scars. Shell white, sometimes vitreous and transparent; nacreous internally.



Plate 121. Figs. 1, 2 and 3. *Pandora (Clidiophora) trilineata* Say 1822. USNM 61028, Tampa, Florida, in 6 fathoms. Fig. 1. Internal view of the right valve (about 3.8x). Fig. 2. Internal view of the left valve (about 3.8x). Fig. 3. External view of the left valve (about 4.5x). Fig. 4. *Pandora (Clidiophora) gouldiana* Dall 1886. Internal view of the left valve of a paratype, USNM 95490, Woods Hole, Massachusetts (about 2.4x). (Specimen sprayed with ammonium chloride vapor.)

length	height	width	
19/20 in.	9/20 in.	??	Holotype of <i>trilineata</i> Say (original measurements)
29.3 mm.	13.8 mm.	—	Pensacola, Florida
23.6	10.6	1.9 mm.	<i>Eolis</i> , Station 21, off Beaufort, North Carolina
19.9	8.9	1.9	Tampa, Florida
17.9	7.8	1.7	" "
14.8	5.8	1.4	Matagorda Bay, Texas
14.1	6.6	1.6	<i>Fish Hawk</i> , Station 8338, off Butler's Bluff, Chesapeake Bay
11.0	5.1	1.3	Carancahua Bay, Texas

Remarks. The original citation of localities by Say included the specific locality, Great Egg Harbor, New Jersey, as well as the general locality "the coast of Georgia and East Florida." The specimen figured is the elongate, slender species which is found in the south but not in the north. The differences between northern and southern species were detected by Gould, who suggested that Say's figure was incorrect in its representation of the species in Massachusetts. Dall recognized that a subrectangular, more roughly

sculptured species inhabited northern waters while a sharply rostrate, narrowly arcuate species was found in the south.

Today the close propinquity of *trilineata* and *gouldiana* is recognized. A full account of the differences which serve to distinguish these species has been given under Remarks on *gouldiana* (see p. 192).

The separation of these two closely related species in their allopatric distributions may be dated from the Miocene. Gardner (1943) has discussed the *Clidiophora* of the Miocene and Pliocene formations and has shown that *Pandora toumeyi* Gardner and Aldrich appears to be an early representative in the lineage of *trilineata*. Dall (1903) gives a number of Miocene, Pliocene and Pleistocene localities for *trilineata* and its precursors. Maury (1920) has listed this species in the Pleistocene near New Orleans, and Richards (1962) has given a number of Pleistocene localities along the Atlantic coastal plain. The consolidation of the dentition into more definitive structures and into more stable configurations appears to be a trend in the evolution of this species since the Miocene.

Pandora trilineata is found in shallow waters from 1 to 24 fathoms, most often in mud substrates, but the species also occurs in sandy bottoms and even in shell-gravel substrates. Parker (1956, 1959) and Ladd (1951) have shown that the species appears to be most abundant in conditions of high salinities in the passes and protected bays along the Texas coast.

Range. *Pandora trilineata* is found north of Cape Hatteras as far as Chesapeake Bay. It occurs south through Florida and in the Gulf of Mexico to Port Aransas in western Texas.

Specimens examined. VIRGINIA: *Fish Hawk*, Station 8595, Chesapeake Bay, in 12 fathoms; *Fish Hawk*, Station 8338, off Butler's Bluff, Chesapeake Bay, in $3\frac{3}{4}$ fathoms; *Fish Hawk*, Station 8500, off Cape Henry, Chesapeake Bay, in 9 fathoms (all USNM); *Delaware*, Station 6, tow 2, 50 miles E of Cape Henry ($36^{\circ}53' N$; $74^{\circ}59' W$), in 20 fathoms (MCZ). NORTH CAROLINA: *Delaware*, Station 8-7, alt. tow 10, 35 miles NE of Cape Hatteras ($35^{\circ}32' N$; $74^{\circ}57' W$), in 24 fathoms (live); *Delaware*, Station 8, tow 1, 18 miles NE of Cape Hatteras ($35^{\circ}24' N$; $75^{\circ}12' W$), in 14 fathoms (live) (both MCZ); *Albatross I*, Station 2597, 20 miles E of Swash Inlet, between Cape Hatteras and Cape Lookout ($34^{\circ}57' N$; $75^{\circ}43' W$), in 15 fathoms; shoals west of Pivers Island (near Beaufort); *Eolis*, Station 21, off Beaufort, in 6-9 fathoms; *Albatross I*, Station 2619, 25 miles SE of Cape Fear ($33^{\circ}38' N$; $77^{\circ}36' W$), in 15 fathoms (all USNM). SOUTH CAROLINA: Charleston (MCZ); Beaufort (USNM). FLORIDA: Manatee River; $3\frac{3}{4}$ miles SSW off Longboat Pass, Manatee County, in 6 fathoms (both USNM); Tampa Bay (live) (MCZ); Tampa, in 6 fathoms (USNM); Pensacola (MCZ; USNM). TEXAS: Galveston (MCZ); Matagorda Bay; Carancahua Bay; Pass Cabello, Matagorda Island (all USNM); Port Aransas (MCZ).

***Pandora (Clidiophora) inornata* Verrill and Bush**

Plate 120, figs. 1-2

Clidiophora inornata Verrill and Bush 1898, Proc. U.S. Nat. Mus. **20**: 819, pl. 95, figs. 5 and 6 (*Speedwell*, Station 327, off Cape Cod, south end of Stellwagen Bank, in 17 fathoms; syntypes, USNM 49760).

Pandora (Clidiophora) inornata Verrill and Bush. Johnson 1915, Occ. Pap. Boston Soc. Nat. Hist. **13**: 38.

Pandora (Clidiophora) inornata Verrill and Bush. Johnson 1934, Proc. Boston Soc. Nat. Hist. 40(1): 31 [error for *Clidiophora* Carpenter].

Description. Shell extending to 19 mm. in length (about $\frac{3}{4}$ inch) and to 12 mm. in height (about $\frac{1}{2}$ inch), elongate, rostrate posteriorly and rounded anteriorly, inequilateral, inequivalve with the left valve convex and the right valve more or less flattened. Umbos in the anterior third of the shell blunt, rounded and inflated in the left valve. Anterior margin broadly rounded and smoothly confluent with the ventral margin; ventral margin gently convex, rising and straight to indented behind; anterior dorsal margin convex and smoothly confluent with the anterior margin; posterior dorsal margin long and slightly concave; posterior margin short and more or less straight and forming an oblique truncation. In the left valve, two weak, divaricating, external, radial ridges posteriorly, the ventral ridge the stronger, and with a weak sulcus separating it from the dorsal ridge. Anterior radial sulcus in the left valve weak, not disrupting the ventral contour of the shell but delimiting the confluence of the anterior margin and the ventral margin. Concentric sculpture weak; coarse growth rings strongly evident, particularly on the left valve. Hinge with a lithodesma, an internal resilium and external ligament. Dentition of the left valve with a strong, thickened anterior cardinal tooth with an excavation above; central cardinal tooth small but developed; posterior lateral tooth consists of a subproximal thickening of the hingeline. Dentition of right valve with a strong, elongate posterior cardinal tooth and a central thickened sublunate, pedunculate cardinal tooth; anterior cardinal tooth consists of an obscure thickening, extending from the umbo to the anterior adductor muscle scar. Adductor muscle scars well impressed, moderately large, subrhomboid to elongate-ovate in shape. Pallial sinus consisting of irregular, individual scars extending between the anterior and posterior adductor muscle scars. Shell white, internally nacreous, externally dirty-white to a light brown and somewhat glabrous.

length	height	width	
16.7 mm.	10.1 mm.	3.4 mm.	Syntype of <i>inornata</i> Verrill and Bush
18.8	11.6	3.6	<i>Speedwell</i> , Station 251, off Race Point Light
18.5	12.0	4.0	“ “ “ “ “ “ “
15.1	10.1	3.8	“ “ “ “ “ “ “
12.0	6.9	2.2	<i>Bache</i> , Station 33B, Stellwagen Bank
11.3	6.7	2.0	<i>Speedwell</i> , Station 327, S end of Stellwagen Bank
10.2	5.2	1.7	<i>Speedwell</i> , Station 251, off Race Point Light

Remarks. *Pandora inornata* is a comparatively rare species of limited geographical distribution. It is easily confused with its close ally, *P. gouldiana* Dall, and, for this reason, has often remained undetected in collections. Both *inornata* and *gouldiana* belong to the subgenus *Clidiophora*, but *inornata* is much more stable in its traits and its range of variation is not as great as that of *gouldiana*. *Pandora inornata* is thicker, more heavily shelled in its youthful stages, stronger, more solid, of a smaller maximum size, of lower proportionate height, and of a less intense nacreous interior. Such traits are difficult to quantify but a closer examination of specimens usually suffices to distinguish each species.

The left anterior cardinal tooth in *inornata* is arcuate and thickened proximally; this tooth terminates distally at or near the uppermost portion of the anterior adductor muscle scar where it forms a weak ridge extending out to the border of the valve; the an-

terior adductor muscle scar therefore appears to be deeply impressed. In *gouldiana*, the anterior cardinal tooth generally descends along the dorso-ventral axis from the umbonal region; however, in the range of variation some specimens of *gouldiana* have an arcuate anterior cardinal tooth but its terminus is more distinct than the homologous structure in *inornata* and there does not appear to be ridge-like extensions of the tooth to the border of the valve. The anterior adductor muscle scar in such specimens of *gouldiana* does not appear to be so strongly impressed.

The anterior dorsal margin of *inornata* tends to be convex, rounded and more or less smoothly confluent with the anterior margin. In contrast, the anterior dorsal margin of *gouldiana* is usually straight or slightly concave and there is a slight flaring rather than a smooth confluence where this margin meets the anterior margin. A definitive ventral ridge and supernumerary ridges are lacking in *inornata* while along the posterior dorsal margin in *gouldiana* there is a double ridge—a strong ventral one which runs completely to the posterior ventral angulation and defines the posterior rostration, and a weaker somewhat obsolete dorsal one. Between these ridges in *gouldiana* there is a depression or weak sulcus.

Range. This species is localized and restricted in distribution from below Nova Scotia to the southern part of Cape Cod and has been taken alive in depths to 35 fathoms.

Specimens examined. NOVA SCOTIA: 14 miles S of Cape Sable, in 45 fathoms (MCZ). MASSACHUSETTS: Jeffries Ledge, in 35 fathoms (live); off Duxbury, in 18 fathoms (live); Stellwagen Bank, in 23 and 35 fathoms (live) (all MCZ); *Bache*, Station 33B, Stellwagen Bank (42°20' N; 70°18' W), in 22 fathoms (live); *Speedwell*, Station 327, S end of Stellwagen Bank (42°11' N; 70°12' W), in 17 fathoms (live) (both USNM); *Gosnold*, Station 1209, S end of Stellwagen Bank (42°10' N; 70°14' W), in 20 fathoms (live) (BCF); *Speedwell*, Station 251, 6¾ miles off Race Point Light (42°10' N; 70°10' W), in 24 fathoms (live) (USNM). *Jenni B*, Stations (035° true north from Provincetown monument) 37, in 14 fathoms (live); 17, in 24 fathoms (live); 19, in 30 fathoms; *Jacqueline*, Stations (064° true north from Cape Cod Light) 33, in 37 fathoms; 6, in 21 fathoms (all BCF); *Fish Hawk*, Station 964, 5 miles SE of Chatham, in 10 fathoms; *Speedwell*, Station 367, 5½ miles ESE of Chatham (41°38' N; 69°49' W), in 12 fathoms (live); *Fish Hawk*, Station 978, 6 miles ESE of Chatham, in 17 fathoms (live); *Fish Hawk*, Station 981, 16 miles ESE of Chatham Light, in 43 fathoms (all USNM).

Subgenus *Pandorella* Conrad

Pandorella Conrad 1863, Proc. Acad. Nat. Sci. Philadelphia, for 1862, p. 572 (type species, by monotypy, *Pandora arenosa* Conrad 1834), non Laseron 1951.

Kennerlia Carpenter 1864 (Aug.), Brit. Assn. Adv. Sci. Report for 1863, pp. 602 and 638; 1864 (Nov.). Proc. Zool. Soc. London, p. 602 (type species, by subsequent designation, Stoliczka 1871, p. 61, *Pandora Kennerlia bicarinata* Carpenter 1864 [= *Pandora* (*Kennerlia*) *bilirata* Conrad 1855]).

Kenerlia Carpenter. Paetal 1875, Fam. Gatt. Moll., p. 103 [error for *Kennerlia* Carpenter].

Kennerleya Carpenter. Fischer 1887, Manuel de Conchy., p. 1158 [emend. for *Kennerlia* Carpenter].

Kennerleyia Carpenter. Dall 1903, Trans. Wagner Free Inst. Sci., Philadelphia 3(6): 1517 [emend. for *Kennerlia* Carpenter].

Kennerlyia Carpenter. Dall 1915, Proc. U.S. Nat. Mus. 49: 448 [error for *Kennerlia* Carpenter].

Panderella Conrad. Palmer 1958, Memoir 76, Geol. Soc. Amer., p. 76 [error for *Pandorella* Conrad].

Vokes (1956) has documented the usage of *Pandorella* and has shown that it is a senior synonym of *Kennerlia*. Palmer (1958), Keen (1958), and Olsson (1961) have adopted the subgeneric name *Pandorella* to replace the previously widely employed *Kennerlia*. According to Dall (1903), the characters which typify the subgenus *Pandorella* (= *Kennerlia*) include the presence of radial lines on the external surface of the right valve and an internal lithodesma or calcified supporting structure attached to the base of the resilium. Further, the dental configuration is typified by an obsolete right anterior cardinal tooth and a left anterior cardinal tooth which is adpressed to or coextensive with the anterior dorsal margin of the valve.

This subgenus, although widely distributed in the northern hemisphere, is particularly well developed in the Western Atlantic and Eastern Pacific areas. Its origin is apparently dated from the Miocene of North America.

***Pandora (Pandorella) arenosa* Conrad**

Plate 122, figs. 1–2; Plate 125, fig. 3

Pandora arenosa Conrad 1834, Jour. Acad. Nat. Sci. Philadelphia, 1st Ser. 7(1): 130–131; 1838, Fossils of medial Tertiary, p. 2, pl. 1, fig. 3 (Yorktown [Miocene], Virginia; syntypes, ANSP 30584).

Myadora arenosa Conrad 1848, Proc. Acad. Nat. Sci. Philadelphia (for 1846) 3: 21.

Pandorella (Pandora) arenosa Conrad 1863, Proc. Acad. Nat. Sci. Philadelphia (for 1862), 2nd Ser. 6: 572.

Pandora oblonga 'Sowerby' Dall 1881, Bull. Mus. Comp. Zool. 9: 109, *non* Sowerby 1830.

Pandora sp. Bush 1885, Report U.S. Comm. Fish and Fisheries for 1883, p. 86.

Pandora carolinensis Bush 1885, Trans. Conn. Acad. 6(2): 474 (USFC *Albatross* I, Station 2113, off Cape Hatteras, North Carolina, in 15 fathoms; holotype, USNM 35701).

Pandora carolinensis Bush. Dall 1885, Bull. U.S. Geol. Sur., no. 24, p. 213 (error for *carolinensis* Bush).

Pandora (Clidiophora) carolinensis Bush. Dall 1886, Bull. Mus. Comp. Zool. 12(6): 311, pl. 8, figs. 8–8a.

Pandora (Kennerleyia) arenosa Conrad. Dall 1903, Trans. Wagner Free Inst. Sci. Philadelphia 3(6): 1518.

Pandora (Kennerleyia) arenosa Conrad. Maury 1920, Bull. Amer. Paleo. 8(34): 40.

Pandora (Kennerlia) arenosa Conrad. Johnson 1934, Proc. Boston Soc. Nat. Hist. 40(1): 31; Gardner 1943, Geol. Sur. Prof. Paper 199-A, p. 45, pl. 10, figs. 16, 19, 20.

Pandora (Pandorella) arenosa Conrad. Olsson 1961, Panamic-Pacific Pelecypoda, Ithaca, N.Y., p. 454.

Description. Shell extending to 20 mm. in length (about 4/5 inch) and to 12 mm. in height (about 1/2 inch), subelliptical, solid, inequilateral and inequivalve with the left valve markedly convex and the right valve weakly concave. Umbos far anterior, in the anterior fifth of the total shell length, weakly pointed and prosogyrous. Anterior margin narrowly rounded, uniting in an indentation with the ventral margin at the anterior radial sulcus. Ventral margin broadly convex, rising arcuately and with an indentation behind. Anterior dorsal margin weakly convex in the left valve, weakly concave in the right. Posterior dorsal margin long, gently inclined, descending along its length and somewhat concave far posteriorly. Posterior margin short, oblique and irregular, forming a blunt rostrate truncation. Left valve with an external posterior curvilinear ridge extending from the umbo to the base of the posterior margin and delineating the posterior slope as well as the posterior rostration. An interior radial sulcus extends from the umbo ventrally, dividing the anterior margin and the ventral margin. Along this sulcus the concentric sculpture is depressed. Right valve with an external radial ridge dorsally, and directly ventral to it, a strong radial sulcus. Concentric sculpture consisting of closely spaced, fine lirations, stronger in the left valve and flexed along the anterior radial sulcus. Radial lines occur in the right valve. Hinge with a lithodesma, an internal

resilium, and an external ligament, particularly evident along the anterior dorsal margin of the left valve. Dentition of the right valve consists of a thickened, moderately elongate posterior cardinal tooth, a central rectangular pedunculate cardinal tooth, and an obscure anterior thickening representing the anterior cardinal tooth. Dentition of the left valve consists of a thickened, horizontal tooth above which is a concave excavation,

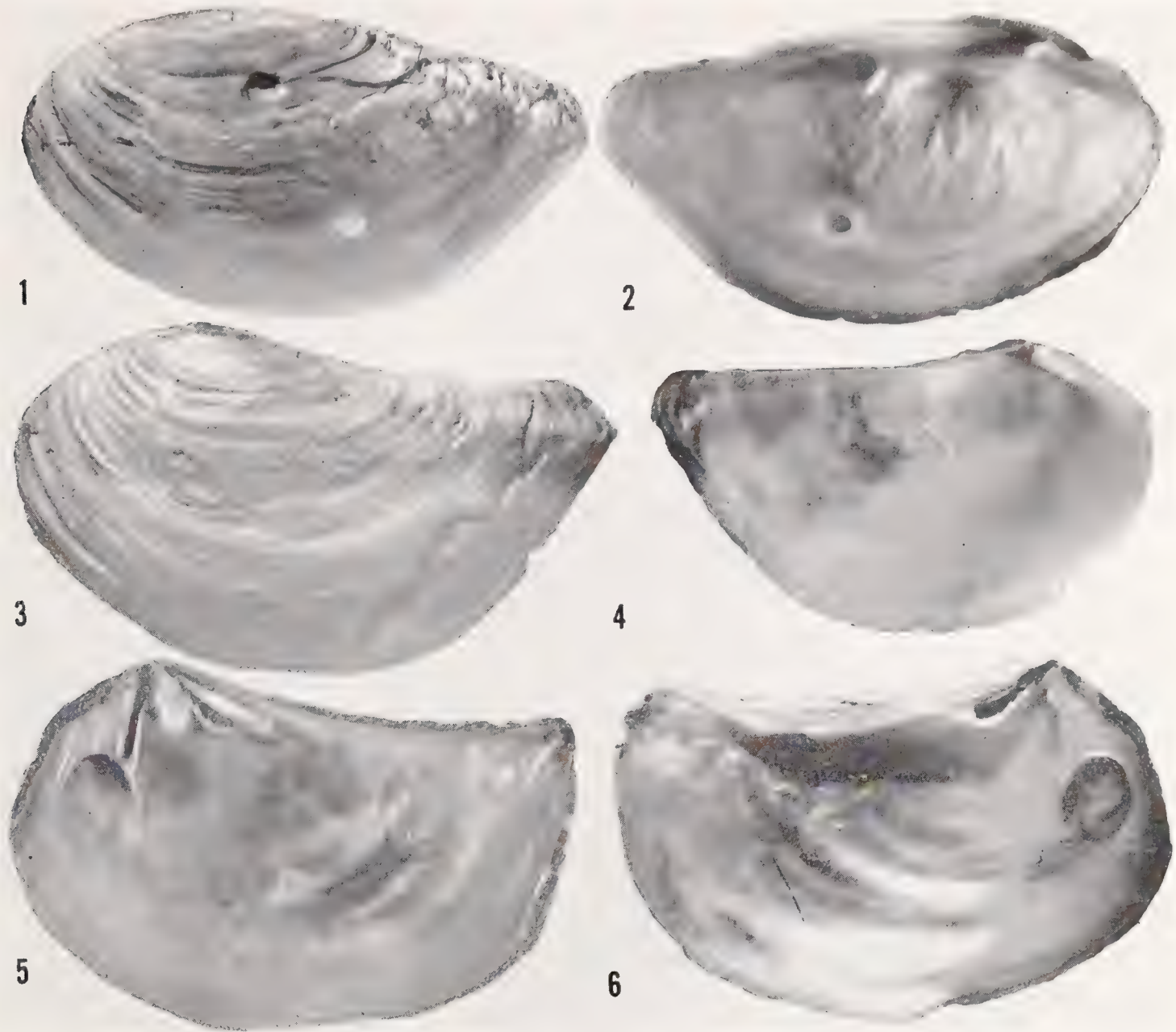


Plate 122. Figs. 1 and 2. *Pandora carolinensis* Bush 1855 [= *Pandora (Pandorella) arenosa* Conrad 1834]. USNM 35701, *Albatross* I, Station 2113, off Cape Hatteras, North Carolina, in 15 fathoms. Fig. 1. External view of the left valve of the holotype (about 5.8x). Fig. 2. Internal view of the left valve of the holotype (about 5.8x). Figs. 3 and 4. *Pandora (Kennerlyia) glacialis* var. *eutaenia* Dall 1915 [= *Pandora (Pandorella) glacialis* Leach 1819]. USNM 171062, Sitka Harbor, Alaska, in 15 fathoms. Fig. 3. External view of the left valve of a syntype (about 2.8x). Fig. 4. Internal view of the left valve of a syntype (about 3x). Figs. 5 and 6. *Pandora (Clidiophora) gouldiana* Dall 1886. USNM 95490, Woods Hole, Massachusetts. Fig. 5. Internal view of the right valve of a paratype (about 3x). Fig. 6. External view of the left valve of a paratype (about 2.6x).

a central thin cardinal tooth in the resilial complex and the posterior cardinal tooth which consists of a thickening of the posterior dorsal margin. Adductor muscle scars impressed, small and subcircular; the anterior adductor muscle scar in the left valve partly obscured under the concavity of the anterior lamina. Pallial line consisting of individual and numerous, well impressed scars, forming a series of punctations extending between the an-

terior adductor and posterior adductor muscle scars. Shell white, highly shining and nacreous internally, dull, somewhat chalky and slightly eroded externally.

length	height	width	
13.5 mm.	7.5 mm.	2.6 mm.	Holotype of <i>carolinensis</i> Bush
19.4	11.3	4.0	<i>Albatross</i> I, Station 20011, off Vero Beach, Florida
19.0	11.1	—	“ “ “ “ “ “
18.0	11.6	—	“ “ “ “ “ “
16.7	9.1	2.9	<i>Albatross</i> I, Station 2277, off Cape Hatteras, N.C.
15.0	8.5	3.1	“ “ “ “ “ “
8.3	4.1	—	<i>Albatross</i> I, Station 2112, off Cape Hatteras, N.C.
7.1	3.3	—	<i>Albatross</i> I, Station 2114, off Cape Hatteras, N.C.

Remarks. *Pandora arenosa* is small and heavily shelled. It is primarily characterized by its highly nacreous interior and its strong convexity of the left valve. In the Western Atlantic it may be confused with *Pandora bushiana* Dall. From the latter, which is its nearest relative in this area, *arenosa* may be distinguished by its strongly curvilinear posterior radial ridge, its more rostrate form and its thicker and heavier shell. *Pandora bushiana* tends to be more narrowly elongate and more compressed than *arenosa* and it is not as nacreous. Immature or small individuals of *arenosa* do not possess the ventral inflation of the adults and they are of more narrow proportions, being somewhat lanceolate in outline. Such young specimens might easily be confused with *bushiana*, but they may be distinguished specifically by their strong rotundity and their developed left anterior cardinal tooth. *Pandora inflata* (= *brevis* Verrill and Bush) which also may be confused with *arenosa* is thin and in some cases translucent; its posterior margin is blunt and not rostrate; its radial posterior ridge is not curvilinear, is generally more widely removed from the posterior dorsal margin and is also not completely carinate to the posterior margin.

Pandora arenosa has some structural features in common with *Pandora filosa* Carpenter of the Pacific Northwest, but *filosa* is not as strongly enrolled (convex in the left valve), nor does it possess as distinct a posterior ridge.

The original description of *Pandora carolinensis* Bush is incorrect in its orientation of the anterior and posterior parts of the animal and the shell, that is, directions are reversed. The first figure for *carolinensis* Bush is that of Dall (1886, pl. 8, figs. 8a-b) and it compares with the type figure of *arenosa* Conrad. Dall first synonymized *carolinensis* with *arenosa* and there appears to be no question concerning this treatment.

The fossil history of *arenosa* begins in the Miocene. Indeed, the recent species is based on Conrad's description of a shell from the Miocene of Yorktown, Virginia. A number of other named fossil forms represent very close relatives of *arenosa*. In Miocene formations, these include *Pandora dodona* Dall from the Oak Grove Sands of Florida, *Pandora lata* Dall from St. Mary's, Maryland, and *Pandora dalli* Gardner from the St. Mary's formation, Virginia. *Pandora naviculoides* Gardner is another close ally from the Pliocene Waccamaw formation, North Carolina. *Pandora arenosa* has also been recorded from the Pliocene of the Caloosahatchee marl, Shell Creek, Florida (Maury, 1920) and from the Pleistocene of North Carolina (Richards, 1962).

This species was very well represented in the *Albatross* dredgings off Cape Hatteras, but rarely was the species encountered alive. Off Florida where known living specimens have been collected, the species appears to prefer a coarse substrate in shallow water.

Range. *Pandora arenosa* is found from off Currituck Beach, North Carolina south to the Gulf of Mexico as far west as Texas and as far south as Yucatan, Mexico, in depths to 20 fathoms (live) and 640 fathoms (dead). Perry and Schwengel (1955) have reported it off Sanibel Island in the Gulf of Mexico from 4–6 fathoms. Singley (1893) and Pulley (1952) have recorded it from Texas.

Specimens examined. NORTH CAROLINA: *Delaware*, Station 7–6, alt. tow 12, 44 miles E of Currituck Beach ($36^{\circ}19' N$; $74^{\circ}55' W$), in 29 fathoms (MCZ); *Albatross I*, Station 2307, 30 miles ESE of Oregon Inlet ($35^{\circ}42' N$; $74^{\circ}54' W$), in 43 fathoms (USNM); *Albatross I*, Station 2112, 12 miles ENE of Cape Hatteras ($35^{\circ}20' N$; $75^{\circ}18' W$), in 15 fathoms; *Albatross I*, Station 2277, $9\frac{1}{2}$ miles ENE of Cape Hatteras ($35^{\circ}20' N$; $75^{\circ}19' W$), in 16 fathoms; *Albatross I*, Station 2113, 8 miles ENE of Cape Hatteras ($35^{\circ}20' N$; $75^{\circ}19' W$), in 15 fathoms; *Albatross I*, Station 2114, 11 miles E of Cape Hatteras ($35^{\circ}20' N$; $75^{\circ}20' W$), in 14 fathoms; *Albatross I*, Station 2615, 28 miles SE of Cape Fear ($33^{\circ}45' N$; $77^{\circ}25' W$), in 18 fathoms (live) (all USNM). SOUTH CAROLINA: *Miss Kim*, Station 9, $37\frac{1}{2}$ miles, 130° off Sandy Point, Raccoon Key ($32^{\circ}28' N$; $78^{\circ}47' W$), in 20 fathoms (live) (MCZ). FLORIDA: *Albatross I*, Station 20011, off Vero Beach, in 46 fathoms (USNM); off Sanibel Island, in 6 fathoms; off Charlotte Harbor, in 13 fathoms (both MCZ); Sarasota Bay (live); $3\frac{3}{4}$ miles SSW of Longboat Pass, Manatee County, in 6 fathoms (live) (both USNM); 120 miles W of Clearwater, in 34–36 fathoms (MCZ). MEXICO: *Albatross I*, Station 2361, off Cabo Catoche, Yucatan ($22^{\circ}08' N$; $86^{\circ}51' W$) (USNM); *Blake*, Yucatan Strait, in 640 fathoms (MCZ).

***Pandora (Pandorella) bushiana* Dall**

Plate 123, figs. 1–3

Pandora (Kennerlia) bushiana Dall 1886, Bull. Mus. Comp. Zool. **12**(6): 312 (Tampa, Florida, in 6 fathoms; holotype, USNM 61029).

Pandora (Kennerleyia) bushiana Dall 1902, Proc. United States Nat. Mus. **24**: 511, pl. 31, fig. 3.

Pandora (Kennerleya) bushiana Dall. Maury 1920, Bull. American Paleo. **8**(34): 40.

Description. Shell extending to 16 mm. in length (about $\frac{5}{8}$ inch) and to 8 mm. (about $\frac{3}{8}$ inch) in height, thin to fragile, narrowly elongate, inequilateral, inequivalve with the left valve convex and the right valve somewhat concave. Umbos placed in the anterior fifth of the valve, small and pointed. Anterior margin narrowly rounded, weakly convex, and with an indentation becoming confluent with the ventral margin at the anterior radial sulcus; ventral margin broadly rounded, convex, rising posteriorly and sometimes indented posteriorly; anterior dorsal margin somewhat concave, sigmoid, and descending; posterior dorsal margin very long, weakly convex, gently descending and sometimes weakly ascending posteriorly; posterior margin short, irregular and forming a blunt subrostrate truncation. In the left valve, a single weakly carinate, subcurvilinear ridge extends from the umbo to the base of the posterior margin behind; the anterior radial sulcus nearly perpendicular and defining the confluence of the anterior margin with the ventral margin. In the right valve, two ridges dorsally and two weak radial, subsigmoid sulci extending from the umbo to the posterior margin. Concentric sculpture weak, finely incised and closely set. Hinge with an internal resilium, a lithodesma and an external ligament. Dentition of left valve with a flattened, partly protruding anterior cardinal tooth with a concave surface; the external ligamental area, excavated above this

tooth, is very narrow; central cardinal weak, fine, and bordering the resilial pit; posterior cardinal tooth long, thin, laminate and coextensive with the thickened hinge line. Dentition of right valve with a long thin posterior cardinal tooth, a narrow pedunculate central cardinal tooth; no true anterior cardinal tooth, but localized thickenings along the anterior dorsal margin and near the anterior adductor muscle scar do occur. Adductor muscle scars well impressed and rounded. Pallial sinus consists of individual scars extending between the anterior muscle scar and the posterior adductor muscle scar. Shell white, covered with a brownish white periostracum with superficial radiations evident externally on the left valve, nacreous but not highly shining internally.



Plate 123. Figs. 1 and 2. *Pandora (Pandorella) bushiana* Dall 1886. USNM 599331, off Destin, Florida, in 20 fathoms. Fig. 1. External view of the left valve (about 7.3x). Fig. 2. Internal view of the right valve (about 7.4x). Fig. 3. *Pandora (Kennerlia) bushiana* Dall 1886 [= *Pandora (Pandorella) bushiana* Dall]. External view of the left valve of a syntype. USNM 61029, Tampa, Florida, in 6 fathoms (about 8.6x).

length	height	width	
11.5 mm.	5.5 mm.	1.0 mm.	Holotype of <i>bushiana</i> Dall
15.2	7.7	1.8	off Destin, Florida, in 20 fathoms
11.9	5.2	1.0	<i>Barrera</i> , Station 208, off Bahía Honda, Cuba, in 1-12 fathoms
8.9	4.1	0.8	“ “ “ “ “ “ “ “ “ “

Remarks. This species is rather poorly known. It appears to be a more tropical species with some distribution in the Antilles. According to Warmke and Abbott (1961), it is commonly encountered in dredgings. Established depth records for the species indicate a shallow water habitat not exceeding 25 fathoms, and Perry and Schwengel (1955) have listed its occurrence off Sanibel Island in 4-6 fathoms. Parker (1956) found it dead at eight stations in the deep shelf zone along the Texas coast.

The presence of a lithodesma and the union of the left anterior cardinal tooth with the anterior hinge line places this species within the confines of *Pandorella*. Its closest relative appears to be *Pandora arenosa* which is a more strongly and heavily shelled species. *Pandora bushiana* is less convex in the left valve and when living, is covered with a light brownish periostracum. In addition, its left anterior cardinal tooth tends to be somewhat weakened and concave. Another species with which *bushiana* may be confused is *Pandora inflata* which is swollen ventrally and broadly truncated posteriorly. According to Dall's original comments, *bushiana* possesses a convex posterior dorsal margin and its rostrum points ventrally. Both these traits may be observed in the species but they are neither constant nor diagnostic.

Range. *Pandora bushiana* occurs from off Cape Fear, North Carolina south through the Florida Keys to the northern part of Florida, the Bahama Islands, Cuba and south to Yucatan. It has been found living in depths to 25 fathoms.

Specimens examined. NORTH CAROLINA: *Albatross* I, Station 2615, 27 miles ESE of Cape Fear (33°45' N; 77°25' W), in 18 fathoms (live) (USNM). SOUTH CAROLINA: *Miss Kim*, Station 9, about 37½ miles, 130° off Sandy Point, Raccoon Key (32°34' N; 78°51' W), in 10 fathoms (live); *Miss Kim*, Station 11, about 43¼ miles, 130° off Sandy Point, Raccoon Key (32°31' N; 78°51' W), in 25 fathoms (live) (both MCZ). FLORIDA: *Eolis*, Station 83, off Government Cut, Miami, in 3 fathoms (live) (USNM); 5 miles E of Carysfort Light, in 96-107 fathoms (MCZ); *Eolis*, Station 33, off Tortugas, in 16 fathoms (live) (USNM); off Sanibel Island, in 6 fathoms (live) (MCZ); off Tampa, in 6 fathoms (live) (USNM); off Destin, in 18-20 fathoms (MCZ; USNM); off Fort Walton, in 16-19 fathoms (MCZ). BAHAMAS: Moraine Cay (MCZ); *Eolis*, Station 50, N. Bimini Island, in 20 fathoms (USNM). CUBA: *Barrera*, Station 208, off Bahía Honda, in 1-12 fathoms (live) (USNM). MEXICO: *Albatross*, Station 2361, off Cabo Catoche, Yucatan (22°08' N; 86°15' W), in 25 fathoms (USNM).

***Pandora (Pandorella) inflata*, new name**

Plate 124, figs. 1-4; Plate 125, figs. 1-2

Kennerlia glacialis 'Leach' Verrill 1881, Proc. United States Nat. Mus. 3: 397, non Leach 1819.

Pandora (Kennerlia) glacialis 'Leach' Dall 1889, Bull. United States Nat. Mus., no. 37, p. 69, pars, non Leach 1819.

Kennerlia brevis Verrill and Bush 1898, Proc. United States Nat. Mus. 20: 821, pl. 88, figs. 7a-b (*Albatross* I, Station 2248, 67 fathoms, S of Nantucket, Massachusetts; holotype, USNM 40232), non Sowerby 1829.

Pandora (Kennerlia) brevis Verrill and Bush. Johnson 1934, Proc. Boston Soc. Nat. Hist. 40(1): 31, non Sowerby 1829.



Plate 124. Figs. 1 and 2. *Pandora (Pandorella) inflata*, new name. Fig. 1. External view of the left valve. USNM 444729, *Eolis*, Station 309, off Fowey Light, Florida, in 60 fathoms (about 8.3x). Fig. 2. Internal view of the right valve. USNM 323233, *Albatross I*, Station 2369, off Cape San Blas, Florida, Gulf of Mexico, in 26 fathoms (about 6.8x). Fig. 3. *Kennerlia brevis* Verrill and Bush 1898, non Sowerby 1829 [= *Pandora (Pandorella) inflata*, new name]. External view of the right valve of the holotype. USNM 40232, *Albatross I*, Station 2248, S of Nantucket, Massachusetts, in 67 fathoms (about 8.3x). Fig. 4. *Pandora (Pandorella) inflata*, new name. External view of the right valve. USNM 444729, *Eolis*, Station 309, off Fowey Light, Florida, in 60 fathoms (about 7.9x).

Description. Shell extending to 18 mm. in length (about $\frac{3}{4}$ inch) and to 9 mm. in height (about $\frac{3}{8}$ inch), subsolid to fragile, somewhat translucent, inequilateral, inequivalve, with the left valve markedly convex and tumid and the right valve concave. Umbos situated in the anterior quarter of the valve, small and somewhat pointed. Anterior margin narrow, short, weakly convex and markedly distinct from the ventral margin; ventral margin broadly convex, rising but not indented behind; anterior dorsal margin gently descending and weakly convex; posterior dorsal margin more or less straight, long, and slightly descending; posterior margin confluent with the ventral margin, nearly straight and forming a broad blunt truncation. Left valve with a strong anterior radial sulcus which strongly delimits the confluence of the anterior margin and the ventral margin. Left valve with two radial posterior ridges, the ventral one the stronger and more carinate. The posterior ridges rarely extend all the way to the posterior margin. In the right valve there are two radial ridges along the posterior dorsal margin and ventral to these are two distinct radial sulci extending posteriorly from the umbo. Concentric sculpture consisting of closely spaced, weakly incised sulci; radial sculptural lines evident in the right valve. Hinge with an internal resilium, a lithodesma and an external ligament. Dentition of the left valve consists of a strongly curved an-

terior cardinal tooth with an excavated ligamental concavity above it, a resilial complex consisting of a medial ridge and an excavated resilial pit; posterior cardinal tooth a mere thickening along the posterior dorsal margin. Dentition of the right valve consists of an angular, thin posterior cardinal tooth with an internal ray beneath extending to the posterior adductor muscle scar, a straight central pedunculate tooth, no true anterior tooth, but a thickening of the anterior dorsal margin at the hinge line and a thickening dorsal to the anterior adductor muscle scar. Adductor muscle scars well impressed, small and rounded. In the left valve, the anterior adductor muscle scar is beneath the cavity of the anterior cardinal tooth. Pallial sinus consists of weak, individual, punctations extending between the anterior and posterior adductor muscle scars. Shell dirty white externally, nacreous internally and shining externally, particularly along the curvature of the left valve.

length	height	width	
9.0 mm.	4.8 mm.	1.2 mm.	Holotype of <i>brevis</i> Verrill and Bush
9.3	5.1	—	Paratype (right valve) of <i>brevis</i> Verrill and Bush
12.6	8.6	—	<i>Albatross</i> I, Station 2268, off Cape Hatteras
12.1	8.8	2.3	<i>Fish Hawk</i> , Station 920, off Manasquan Inlet, New Jersey
11.3	7.3	—	<i>Albatross</i> I, Station 2265, off Cape Henry, Virginia
9.8	6.2	1.5	<i>Eolis</i> , Station 151, off Government Cut, Miami, Florida
6.1	3.3	0.8	<i>Eolis</i> , Station 366, E of Ragged Key, Florida

Remarks. The name *brevis*, introduced by Verrill and Bush for this species, is pre-occupied by the *brevis* of Sowerby. We have chosen the descriptive name *inflata* to apply to this species. *Pandora inflata* appears to be most closely allied to *Pandora glacialis* Leach which is of a more northern distribution. The latter lacks the more or less distinct radial and somewhat carinate ridges of the left valve. The anterior lateral laminar tooth of the left valve in *inflata* has an excavated area above it whereas in *glacialis* this tooth appears to be flush with the anterior dorsal margin of the hinge line and the excavated area, if at all present, is very much reduced. The swollen convexity of the left valve of *inflata* also is distinct from the more oblate convexity of *glacialis*. The right valve of *glacialis* may be somewhat convex whereas in *inflata* it is somewhat concave.

Pandora inflata may be confused with *P. arenosa* but it may be differentiated by its lack of posterior rostration, distinct division of the anterior margin and the ventral margin caused by the anterior radial sulcus and its radial carinate ridges in the left valve. These ridges in *arenosa* tend to be curvilinear whereas in *inflata* they are straight. The anterior sulcus is dorso-ventral in *arenosa* while it is somewhat oblique in *inflata*.

In the Eastern Pacific, *Pandora bilirata* Carpenter and *P. convexa* Dall seem most similar to *inflata*. From *bilirata*, which is probably more closely allied, *inflata* may be distinguished by its more pellucid, subtransparent shell and its greater inflation. *Pandora convexa* is a larger species with a rostrate posterior end, which is lacking in *inflata*.

There does not seem to be a record for *Pandora inflata* in Tertiary deposits in North America.

Range. *Pandora inflata* occurs from the latitude of Sandy Hook, New Jersey, south along the east coast and both sides of Florida. It has been found living in depths between 26 and 90 fathoms and appears to be most populous in the Straits of Florida.

Specimens examined. NEW JERSEY: *Delaware*, Station 2-1, alt. tow 50, 126 miles E of Sandy Hook ($40^{\circ}16' \text{ N}$; $71^{\circ}22' \text{ W}$), in 46 fathoms (live) (MCZ); *Albatross I*, Station 2242, 160 miles E of Manasquan Inlet ($40^{\circ}15' \text{ N}$; $70^{\circ}27' \text{ W}$), in 58 fathoms; *Fish Hawk*, Station 920, 150 miles E of Manasquan Inlet ($40^{\circ}13' \text{ N}$; $70^{\circ}41' \text{ W}$), in 63 fathoms; *Albatross I*, Station 2248, 190 miles E of Manasquan Inlet ($40^{\circ}07' \text{ N}$; $69^{\circ}57' \text{ W}$), in 67 fathoms (all USNM); *Delaware*, Station 3-2, alt. tow 31, 73 miles E of Atlantic City ($39^{\circ}20' \text{ N}$; $72^{\circ}52' \text{ W}$), in 40 fathoms (live); *Delaware*, Station 3, tow 5, 101 miles

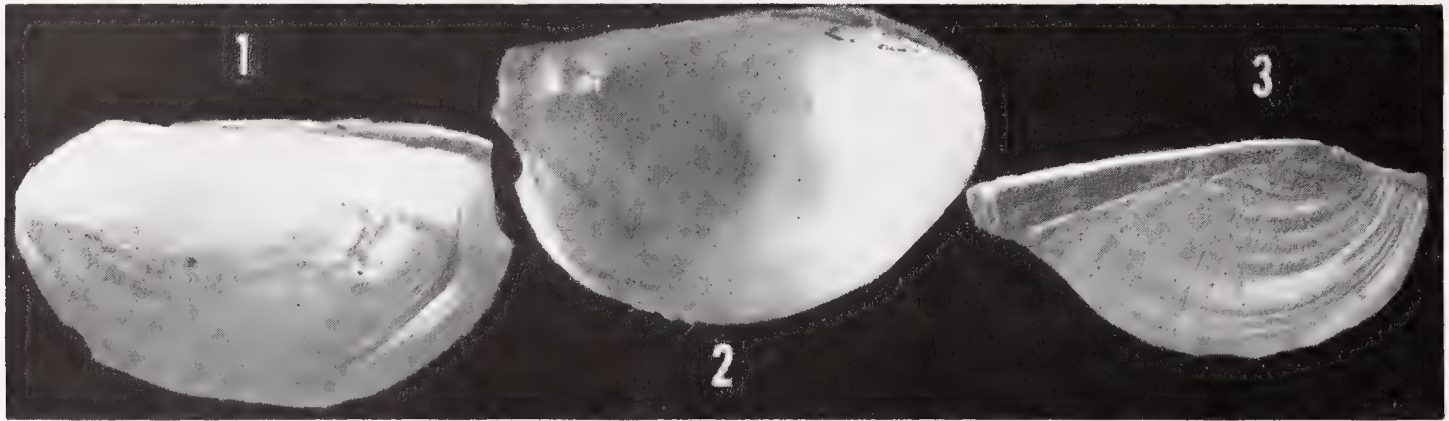


Plate 125. Fig. 1. *Kennerlia brevis* Verrill and Bush 1898, non Sowerby 1829 [= *Pandora (Pandorella) inflata*, new name]. External view of the left valve of the holotype, USNM 40232, *Albatross I*, Station 2248, S of Nantucket, Massachusetts, in 67 fathoms (about 5.7x). Fig. 2. *Pandora (Pandorella) inflata*, new name. Internal view of the left valve. USNM 323233, *Albatross I*, Station 2369, off Cape San Blas, Florida, Gulf of Mexico, in 26 fathoms (about 4.6x). Fig. 3. *Pandora carolinensis* Bush 1885 [= *Pandora (Pandorella) arenosa* Conrad 1834]. External view of the right valve of the holotype. USNM 35701, *Albatross I*, Station 2113, off Cape Hatteras, North Carolina, in 15 fathoms (about 3.6x).

E of Cape May ($39^{\circ}00' \text{ N}$; $72^{\circ}48' \text{ W}$), in 80 fathoms (live) (both MCZ). VIRGINIA: *Albatross I*, Station 2265, 65 miles E of Cape Henry ($37^{\circ}07' \text{ N}$; $74^{\circ}35' \text{ W}$), in 70 fathoms (USNM). NORTH CAROLINA: *Albatross I*, Station 2268, 20 miles ESE of Cape Hatteras ($35^{\circ}10' \text{ N}$; $75^{\circ}06' \text{ W}$), in 68 fathoms; *Albatross I*, Station 2612, 30 miles SSE of Cape Lookout ($34^{\circ}11' \text{ N}$; $76^{\circ}10' \text{ W}$), in 52 fathoms (all USNM). FLORIDA: Lake Worth (McGinty) (live); off Palm Beach in 130 fathoms; off S. Palm Beach in 75 fathoms (McGinty) (all MCZ); *Eolis*, Stations off Miami, in 24-60 fathoms; *Eolis*, Stations off Government Cut, Miami, in 25-90 fathoms; *Eolis*, Stations off Fowey Light, in 28-125 fathoms; *Eolis*, Station 189, off Cape Florida, in 67 fathoms (live); *Albatross I*, Station 2646-8, off Cape Florida ($25^{\circ}47' \text{ N}$; $80^{\circ}05' \text{ W}$), in 84-85 fathoms; *Eolis*, Stations off Ragged Key, in 65-90 fathoms; *Eolis*, Station 350, off Triumph Reef, in 70-90 fathoms (live); *Eolis*, Stations off Ajax Reef, in 40-100 fathoms; *Eolis*, Station 376, off Caesars Creek, in 90 fathoms (live); *Eolis*, Station 58, off Turtle Harbor, in 50 fathoms (all USNM); NNE off Carysfort Light, in 100 fathoms (live) (MCZ); *Eolis*, Station 45, Lower Matecumbe Key (shore drift); *Eolis*, Station 145, off Long Reef, in 40 fathoms (both USNM); 6 miles SE of Sombrero Light, in 66 fathoms (live); $\frac{1}{2}$ mile SSE of Looe Key, in 29 fathoms (both MCZ); *Eolis*, Stations off Sambo Key, in 50-75 fathoms; *Albatross I*, Station 2315, off Key West ($24^{\circ}26' \text{ N}$; $81^{\circ}48' \text{ W}$), in 37 fathoms; *Eolis*, Stations off Key West, in 55-63 fathoms; *Eolis*, Stations off Sand Key, in 58-62 fathoms; *Eolis*, Station off Dry Tortugas, in 16 fathoms; *Albatross I*, Station 2369, off Cape San Blas ($29^{\circ}16' \text{ N}$; $85^{\circ}32' \text{ W}$), in 26 fathoms (live) (all USNM).

Pandora (Pandorella) glacialis Leach

Plate 122, figs. 3-4; Plate 126, figs. 1-4

Pandora glacialis Leach 1819 (June), Journal de Physique **88**: 465; 1819 (July), [in] Ross. Voyage of Discovery . . . Baffin's Bay, 2nd Ed., Appx. 4, p. 174; 1819 (Sept.), Annals of Philosophy **14**: 203-204 (Baffin's Bay . . . Spitzbergen, here restricted to Baffin's Bay; syntypes, BMNH, Reg. No. 196273).

Pandora (Kennerlia) glacialis Leach. Carpenter 1864, Proc. Zool. Soc. London, p. 603.

Kennerlia glacialis Leach. Bush 1883, Proc. United States Nat. Mus. **6**: 245, figs. 1-1a.

Pandora (Kennerlyia) glacialis Leach. Dall 1915, Proc. United States Nat. Mus. **49**: 448.

Pandora (Kennerlyia) glacialis var. *eutaenia* Dall 1915, Proc. United States Nat. Mus. **49**: 449 (Sitka Harbor, Alaska, in 15 fathoms; syntypes, USNM 171062).

Pandora (Kennerlyia) glacialis Leach. Oldroyd 1924, Marine Shells West Coast North America **1**: 89, pl. 15, fig. 11 and pl. 42, figs. 3-4.

Pandora (Kennerleya) glacialis Leach. Lamy 1924, Jour. de Conchy. **78**: 112.

Pandora (Kennerleya) glacialis var. *eutaenia* Dall. Lamy 1924, Jour. de Conchy. **78**: 113.

Pandora (Kennerlia) glacialis glacialis Leach. LaRocque 1959, Catalogue Rec. Moll. Canada, Nat. Mus. Ottawa, Bull. **129**: 44.

Pandora (Kennerlia) glacialis eutaenia Dall. LaRocque 1959, Catalogue Rec. Moll. Canada, Nat. Mus. Canada, Ottawa, Bull. **129**: 44.

Description. Shell extending to 22 mm. in length (about $\frac{7}{8}$ inch) and to 19 mm. in height (about $\frac{3}{4}$ inch), elongate, thin and rather fragile, inequilateral, markedly inequivalve with the left valve convex and centrally inflated and the right valve centrally flattened and sharply concave ventrally; the right valve overlaps the left valve dorsally along the posterior dorsal margin. Umbos anterior, about one-third the total length from the anterior margin, blunt and generally eroded. Anterior margin narrowly rounded, uniting in an indentation with the ventral margin at the anterior radial sulcus; ventral margin broadly rounded, convex and uniting smoothly with the undifferentiated posterior margin, forming a rounded posterior end. Anterior dorsal margin short, nearly straight to slightly convex; posterior dorsal margin long and straight to weakly concave. Left valve with a weak anterior radial sulcus, sharply delimiting the confluence of the anterior margin with the ventral posterior ridge or sulcus lacking so that the umbonal inflation is smooth. Right valve with a weak single posterior radial ridge along the posterior dorsal margin where the overlap with the left valve occurs. Concentric sculpture closely spaced, generally worn away; radial lines evident on the right valve. Hinge with a lithodesma and internal resilium. Dentition of the right valve consists of a long posterior laminate cardinal tooth, a central subtrigonal pedunculate cardinal tooth and an obsolete (or completely absent) anterior cardinal tooth; an extensive external ligament along the anterior dorsal margin present. Dentition of the left valve with a thickened anterior cardinal tooth coextensive with the anterior dorsal margin; weak central cardinal tooth; posterior cardinal tooth formed by a thickening along the posterior dorsal margin. Adductor muscle scars impressed, particularly the anterior scar in the right valve; pallial line consists of irregularly arranged individual scars. Shell white, shining internally, chalky and eroded externally; erosion often reveals the nacreous layer of the left valve externally; perios-tracum thickened and dull dirty white.

length	height	width	
21.2 mm.	13.5 mm.	3.8 mm.	Between Cape Mugford and Hebron, Labrador, in 60 fathoms
20.6	11.0	3.8	Bight, Shannon Island, N.E. Greenland
12.8	7.9	2.6	King Francis Joseph Fjord, N.E. Greenland
12.1	7.4	2.3	Collingham's Cove, Hamilton Inlet, Labrador, in 7 fathoms
9.4	5.3	1.5	Grande Creve, Gaspé, Quebec, in 20-40 fathoms

Remarks. In the Western Atlantic, *Pandora glacialis* stands more or less widely separated from other *Pandora*. It is distinguished by its left anterior cardinal tooth which is coalesced with the anterior dorsal margin of the shell. There does not appear to be an excavated cavity dorsal to this tooth. Verrill (1881) identified some specimens as *glacialis* which later proved to be a new species, *Pandora brevis* Verrill and Bush (*non* Sowerby) (= *P. inflata*), which may be confused with *glacialis*. The presence of a carinate ridge and the swollen ventral portion of the left valve of *inflata* immediately separates it from *glacialis*.



Plate 126. Figs. 1-4. *Pandora (Pandorella) glacialis* Leach 1819. Figs. 1 and 2. USNM 444667, between Cape Mugford and Hebron, Labrador. Specimens sprayed with ammonium chloride vapor. Fig. 1. Internal view of the right valve (about 3.9x). Fig. 2. Internal view of the left valve (about 3.3x). Figs. 3 and 4. USNM 50680, Albatross I, Station 2499, N of Sable Island, in 130 fathoms. Fig. 3. External view of the right valve (about 2.9x). Fig. 4. External view of the left valve (about 3x).

Ockelmann (1958) has reported that *glacialis* is a member of the *Gomphia fluctuosa* community in East Greenland, occurring at depths between 3 and 10 fathoms on sandy bottoms near the open sea. The species is hermaphroditic (Thorson, 1936), and Ockelmann has indicated that spawning takes place later than mid-August in East Greenland and that the larval development is lecithotrophic with a pelagic stage which is either very short or entirely lacking. It appears that *glacialis* is a filter feeder and Odhner (1915) has recorded the presence of mud and plankton in the alimentary canal.

An amphipod, *Metopa groenlandica* Hansen, has been reported attached to the ctenidia of specimens of *glacialis* collected in East Greenland (Stephensen and Thorson, 1936).

From samples of living populations, the depth range of this species is between 3 and 130 fathoms. As Clarke (1962) has pointed out, Gorbunov's record (1946) of 1040 fathoms represents a dead specimen which occurred advectitiously at this great depth. Soft bottom types, including mud, sand, and muddy sand are preferred by *glacialis*.

Some ecological factors must contribute to the peculiarly large specimens of this species along the Alaskan coast from Prince Williams Sound to Sitka, for samples from this area are larger and somewhat more rostrate posteriorly. For these populations, Dall (1915) established the varietal name *eutaenia* which is included in the synonymy.

This species has been found fossil in the Pliocene of California in the Pico formation near Ventura (Waterfall, 1929). *Pandora arctica* Dall of the Leda Clays of Saco, Maine and of St. John, New Brunswick appears to be an immediate precursor of *glacialis*. Richards (1962) has listed the Pleistocene deposits in which *glacialis* has been found. Feyling-Hanssen (1955) has recorded *glacialis* in the late Pleistocene of West Spitzbergen.

Range. *Pandora glacialis* is predominantly high arctic and circumpolar in its distribution; however, it extends to lower latitudes on both coasts of North America. It is normally found as far south as the Gulf of St. Lawrence on the Atlantic coast and Vancouver Island and the Straits of Juan de Fuca, British Columbia, on the Pacific coast. The species inhabits the Arctic coasts of Canada, Alaska, the Soviet Union and Scandinavia. It has been found in numerous localities in East Greenland (Ockelmann, 1958), but is not known from West Greenland or Iceland. Odhner (1915) gives an extended list of records with references to citations in European literature. The species has been taken alive in depths to 130 fathoms.

Specimens examined. ARCTIC OCEAN: Matochkin Shar (=strait), Novaya Zembya, in 5–6 fathoms; U.S.S. *Corwin*, north of Bering Strait; off Icy Cape, Alaska, in 17 fathoms; off Cape Sabine, Alaska, in 13 fathoms; off Point Belcher, Alaska, in 9 fathoms (all USNM). BERING SEA: U.S.S. *Corwin*, in Bering Straits, in 30 fathoms; north end of Nunivak Island, Alaska, in 9 fathoms; *Albatross* I, Station 3554, off Pribiloff Island ($56^{\circ}34' \text{ N}$; $170^{\circ}19' \text{ W}$), in 62 fathoms (all USNM). NORTH PACIFIC OCEAN: Port Etches, Hinchinbrook Island, in 15 fathoms; Port Mulgrave, Yakutat Bay, in 30 fathoms; Lituya Bay, in 8 fathoms; Sitka Harbor, in 12–15 fathoms; Victoria, Vancouver Island, in 65 fathoms (all USNM). GREENLAND: Bight, Shannon Island (live); Cape Stosch, Godthaabs Gulf, in 7 fathoms; King Franz Joseph Fjord (live) (all USNM). LABRADOR: Halfway between Cape Mugford and Hebron, in 60 fathoms (live); Collingham's Cove, Hamilton Inlet, in 7 fathoms (live) (both USNM). QUEBEC: Grand Greve, Gaspé, in 20–40 fathoms (live) (USNM). NEWFOUNDLAND: *Albatross* I, Station 2458, off SE Newfoundland ($46^{\circ}48' \text{ N}$; $52^{\circ}34' \text{ W}$), in 89 fathoms (USNM). NOVA SCOTIA: *Albatross* I, Station 2499, N of Sable Island ($44^{\circ}46' \text{ N}$; $59^{\circ}55' \text{ W}$), in 130 fathoms (live) (USNM); East of Cape Sable, in 55 fathoms (MCZ). MASSACHUSETTS: Liberty Street, Danvers (live) (MCZ).

* * * *

Notes

The existence of species of *Pandora* along the Atlantic Coast of South America is difficult to document. At least two specific names have been used in the South American literature.

Pandora braziliensis 'Gould ms' Sowerby 1874 [in] Reeve, *Conchologica Iconica* 19: *Pandora*, pl. 2, fig. 15.

Pandora cistula Gould 1850. Proc. Boston Soc. Nat. Hist. **3**: 217; 1852. United States Explor. Exped., Moll., p. 396, pl. 33, figs. 500–500b.

No specimens of any pandorid from South America were available to the authors at the time of this study and therefore neither of the above have been treated systematically in the text.

* * * *

BIBLIOGRAPHY

- Allen, J.A. 1954. On the structure and adaptations of *Pandora inaequalis* and *P. pinna*. Quart. Jour. Micro. Sci. **94**(4): 473–482.
- Allen, J.A. 1961. Development of *Pandora inaequalis* Linné. Jour. Embryol. Exp. Morphol. **9**: 252–268.
- Allen, M.P. and J.A. 1955. On the habits of *Pandora inaequalis* Linné. Proc. Malac. Soc. London **31**: 175–185.
- Apgar, A.C. 1891. Mollusks of the Atlantic coast of the United States south to Cape Hatteras. Jour. New Jersey Nat. Hist. Soc. **2**: 75–162.
- Arvy, L. and J.M. Gaillard. 1956. Castration parasitaire de *Pandora albida* (Röding), *P. inaequalis* L., mollusque pelecypode eulamellibranche par *Cercaria melanocystea* n. sp. cercaire à grande queue resiculeuse. C.R. Acad. Sci., Paris **243**: 1074–1077, 3 figs.
- Atkins, D. 1937. On the ciliary mechanism and interrelationships of lamellibranchs. Pt. 2. Quart. Jour. Micro. Sci. **79**: 379–421.
- Blake, S.F. 1953. The Pleistocene fauna of Wailes Bluff and Langley Bluff, Maryland. Smithsonian Misc. Coll. **121**(12): 32 pp.
- Burne, R.H. 1920. Mollusca. Pt. IV. Anatomy of Pelecypoda. British Antarctic Expedition (Terra Nova), Zool. II, no. 10, pp. 233–256, pls. 1–4.
- Carpenter, W. 1848. Report on microscopic structure of shells. Report Brit. Assoc. Ad. Sci. [for 1847], pp. 93–134, pls. 1–20.
- Chemnitz, J.H. 1795. [in] Martini-Chemnitz. Neues systematisches Conchylien-Cabinet **11**: 211.
- Children, J.G. 1823. Lamarck's Genera of Shells. Quart. Jour. Sci., Lit., and Arts **14**: 301.
- Clarke, A.H. Jr. 1962. Annotated list and bibliography of the abyssal marine mollusks of the world. Nat. Mus. Canada, Bull. 181, 114 pp.
- Cossmann, A.E.M. 1886. Catalogue des coquilles fossiles d'Éocène des environs de Paris. Pelecypodes. Ann. Soc. Roy. Malac. Belgique **21**(4th Ser., vol. 1): 17–186, pls. 1–8.
- Dall, W.H. 1886. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78) and in the Caribbean Sea (1879–80), by the U.S. Coast Survey steamer "Blake", Lieut. Commander C.D. Sigsbee, U.S.N. and Commander J.R. Bartlett, U.S.N. commanding. XXIX. Report on the Mollusca. Part 1. Brachiopoda and Pelecypoda. Bull. Mus. Comp. Zool. **12**(6): 171–318, 19 pls.
- Dall, W.H. 1889. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the southeastern coast of the United States with illustrations of many of the species. U.S. Nat. Mus., Bull. **37**, 221 pp., 74 pls.

- Dall, W.H. 1903. Tertiary fauna of Florida. Transactions of the Wagner Free Institute of Science of Philadelphia **3**(6): 1515-1522.
- Dall, W.H. 1915. A review of some bivalve shells of the group Anatinacea from the west coast of America. Proc. U.S. Nat. Mus. **49**: 441-456.
- Deshayes, G.P. 1848. Histoire naturelle des Mollusques. Mollusques Acephales. Exploration scientifique de l'Algerie, pp. 240-260, Paris.
- Deshayes, G.P. 1860. Description . . . animaux sans vertébrés. Mollusques Acephales Dimyaires. Paris **1**: 912 pp., 89 pls.
- Dodge, H. 1947. The Molluscan genera of Bruguière. Jour. Paleo. **21**(5): 484-492.
- Duvernoy, M. 1853. Mémoires sur le système nerveux des Mollusques Acephales. Mém. Acad. Sci., Paris **24**: 3-312.
- Feyling-Hanssen, R.W. 1955. Stratigraphy of the marine Late-Pleistocene of Billefjorden, Vestspitsbergen. Skrifter norsk Polarinst. **107**: 1-186, 27 pls., 57 figs.
- Gardner, J. 1943. Mollusca from the Miocene and Lower Pliocene of Virginia and North Carolina. Pt. 1. Pelecypoda U.S. Geol. Sur., Prof. Paper 199-A, 178 pp., 23 pls.
- Gorbunov, C.P. 1946. Bottom life of the Novosiberian shoalwaters and the central part of the Arctic Ocean. Dreifuishchaia ekspeditsiia Glavseomorputi na ledokol'nom parokhodi 'G. Sedov', 1937-1940. g.g. Trudy **3**: 30-138. [Not seen by the authors.]
- Gould, A.A. 1841. A report on the Invertebrata of Massachusetts. Cambridge, 373 pp.
- Grant, U.S. IV, and H.S. Gale. 1931. Catalogue of the marine Pliocene and Pleistocene Mollusca of California. Memoirs San Diego Soc. Nat. Hist. **1**: 1,036 pp., 32 pls.
- Gray, J.E. 1847. A list of the genera of recent Mollusca, their synonyms and types. Proc. Zool. Soc. London **15**: 129-219.
- Hertlein, L.G. and A.M. Strong. 1946. Eastern Pacific Expeditions of the New York Zoological Society. 35. Mollusks from the west coast of Mexico and Central America. Pt. IV. Zoologica **31**(3): 93-120, 1 pl.
- Jacot, A.P. 1921. Some marine molluscan shells of Beaufort and vicinity. Jour. Elisha Mitchell Sci. Soc. **36**: 129-145, pls. 11-13.
- Keen, A.M. 1958. Sea shells of tropical west America. Stanford Univ. Press, 624 pp., 1709 figs., 10 color pls.
- Kobelt, W. 1878. Illustriertes conchylienbuch. Nürnberg, 391 pp.
- Lacaze-Duthiers, F.J.H. 1854. Recherches sur les organes genitaux des Acephales Lamellibranches. Ann. Sci. Nat., 4th Ser., Zool. **3**: 155-248, pls. 5-9.
- Ladd, H.S. 1951. Brackish-water and marine assemblages of the Texas coast, with special reference to Mollusks. Publ. Inst. Marine Sci. **2**(1): 125-164.
- Lamarck, J.B.P.A.M. 1799. Prodrome d'une nouvelle classification des coquilles. Mem. Soc. Hist. Nat. Paris, pp. 63-90.
- Maury, C.J. 1920. Recent molluscs of the Gulf of Mexico and Pleistocene and Pliocene species from the Gulf States. Pelecypoda. Pt. 1. Bull. Amer. Paleo. **8**(34): 3-115, 1 pl.
- Menegaux, A. 1890. Recherches sur la circulation des Lamellibranches marins. Besancon, 296 pp.
- Morse, E.S. 1919. Observations on living lamellibranchs of New England. Proc. Boston Soc. Nat. Hist. **35**(5): 139-196.

- Ockelmann, W.K. 1958. The Zoology of East Greenland. Marine Lamellibranchiata. Medd. om Grönland **122**(4): 256 pp., 3 pls.
- Odhner, N. 1912. Morphologische und phylogenetische Untersuchungen über die Nephridien der Lamellibranchien. Zeits. f. wissen. Zool. **100**(2): 348-350.
- Odhner, N. 1915. Die Mollusken des Eisfjordes. Zool. Ergebn. Schwed. Exped. nach Spitzbergen 1908. K. svenska Vetensk. Akad. Handl. **54**(1): 1-274, 13 pls.
- Olsson, A.A. 1961. Mollusks of the Tropical Eastern Pacific. Panamic—Pacific Pelecypoda. Paleontological Research Inst., Ithaca, N.Y., 574 pp., 86 pls.
- Olsson, A.A. and A. Harbison. 1953. Pliocene Mollusca of southern Florida. Acad. Nat. Sci. Phila., Monograph 8, Pt. 1, 361 pp.
- Palmer, K.V.W. 1958. Type specimens of marine mollusca described by P. P. Carpenter from the West Coast (San Diego to British Columbia). Geol. Soc. Amer. Memoir 76, 376 pp., 35 pls.
- Parker, R.H. 1956. Macro-invertebrate assemblages as indicators of sedimentary environments in East Mississippi Delta Region. Bull. Amer. Assoc. Pet. Geol. **40**(2): 295-376, 8 pls.
- Parker, R.H. 1959. Macro-invertebrate assemblages of central Texas coastal bays and Laguna Madre. Bull. Amer. Assoc. Pet. Geol. **43**(9): 2106-2166.
- Parker, R.H. 1960. Ecology and distributional patterns of macro-invertebrates, northern Gulf of Mexico. Recent Sediments, Northwest Gulf of Mexico, 1951-1958. Amer. Assoc. Pet. Geol., Tulsa, pp. 302-381.
- Pelseneer, P. 1911. Les Lamellibranches de l'Expedition du Siboga. Partie Anatomique. Siboga-Expeditie, Monographie 103 a, 125 pp., 26 pls.
- Perkins, G.H. 1869. The molluscan fauna of New Haven. Proc. Boston Soc. Nat. Hist. **13**: 109-163.
- Perry, L.M. and J.S. Schwengel. 1955. Marine shells of the western coast of Florida. Paleontological Research Inst., Ithaca, N.Y., 318 pp., 55 pls.
- Prashad, B. 1932. Pelecypoda of the Siboga Expedition. Siboga-Expeditie, Monographie 53 c, 353 pp., 9 pls.
- Purchon, R.D. 1958. The stomach in the Eulamellibranchia: Stomach Type IV. Proc. Zool. Soc. London **131**: 487-525.
- Pulley, T.E. 1952. An illustrated check list of the marine mollusks of Texas. Texas Jour. Sci. **2**: 167-199, 13 pls.
- Richards, H.G. 1936. Marine shells of James Bay. Amer. Midl. Nat. **17**(2): 528-545.
- Richards, H.G. 1962. Studies of the marine Pleistocene. Pts. 1 & 2. Trans. Amer. Phil. Soc. **52**(3): 1-141.
- Ridewood, W.G. 1903. On the structure of the gills of the Lamellibranchia. Phil. Trans. Roy. Soc. London, Ser. B, **195**: 147-284.
- Röding, P.F. 1798. Museum Boltenianum. Hamburg, 199 pp.
- Schmidt, F.C. 1818. Versuch der Conchylien-Sammlungen. Gotha, 252 pp.
- Sherborn, C.D. and B.B. Woodward. 1906. On the dates of publication of the natural history portions of the Encyclopédie Méthodique. Ann. Mag. Nat. Hist., Ser. 7, **17**: 577-582.
- Singley, J.A. 1893. Contributions to the natural history of Texas. Pt. 1, Texas Mollusca. Preliminary list of the land, fresh water and marine mollusca of Texas. 4th Ann. Report Geol. Survey Texas, Pts. 1 & 2, pp. 299-343.

- Stephensen, K. and G. Thorson. 1936. On the amphipod *Metopa groenlandica* H. J. Hansen found in the mantle cavity of the lamellibranchiate *Pandora glacialis* Leach in East Greenland. Medd. om Grönland **118**(4): 7 pp.
- Stewart, R.B. 1930. Gabb's California Cretaceous and Tertiary type lamellibranchs. Acad. Nat. Sci. Phila., Spec. Publ. No. 3, 314 pp., 17 pls.
- Stoliczka, F. 1871. Memoirs Geol. Survey India. Palaeontologia Indica. Cretaceous Fauna of southern India **3**: 1-537.
- Sullivan, C.M. 1948. Bivalve larvae of Malpeque Bay, Prince Edward Island. Fish. Res. Board Canada. Bull. 77, 36 pp., 22 pls.
- Sumner, F.B., R.C. Osburn, and L.J. Cole. 1913. A biological survey of the waters of Woods Hole and vicinity. Part II. Section III. A catalogue of the marine fauna. Bull. U.S. Bur. Fish., 31, Pt. 2, pp. 545-794.
- Thorson, G. 1936. The larval development, growth and metabolism of Arctic marine bottom invertebrates. Medd. om Grönland **100**(6): 155 pp.
- Verrill, A.E. 1881. Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England, No. 2. Amer. Jour. Sci., 3 ser. **22**: 292-303.
- Vokes, H.E. 1956. Notes on, and rectifications of, pelecypod nomenclature. Jour. Paleo. **30**(3): 762-765.
- Warmke, G.L. and R.T. Abbott. 1961. Caribbean Sea-shells. Narberth, Pennsylvania, 346 pp., 44 pls.
- Waterfall, L.N. 1929. Univ. California Pub., Bull. Dept. Geol. Sci. **18**(3): 71-92, pls. 5-6.
- Winckworth, R. 1934. Names of British Mollusca III. Jour. Conch. **20**(2): 51-53.
- Zittel, K.A. von. (trans. by C. R. Eastman). 1900. Text-book of Palaeontology. New York **1**: 390 pp.

BOOK REVIEWS

Gould, A.A. 1841, *Report on the Invertebrata of Massachusetts*, Cambridge, Mass., pp. xiii + 373, pls. 15. This was the first publication in North America to cover extensively the fauna of a geographic area the size of the State of Massachusetts. All types of mollusks are covered: the land, freshwater and marine forms. A few other Phyla are covered, such as the Crustacea, Annelida and Echinodermata, but not the Insecta. 318 out of 373 pages are devoted to the Mollusca.

The full impact of this volume upon the culture of that period probably will never be fully known. It was a great stimulation to W. H. Dall as a young malacologist as it was to many other scientists. Gould gave a copy to William Stimpson, then only a young man, and this single gift was responsible for his career in the field of malacology.

Gould made all of the 213 beautifully executed figures which were then engraved on copper plates. His descriptions are full and exceedingly clear and understandable.

Gould, A.A., edited by W.G. Binney 1870, *Report on the Invertebrata of Massachusetts*, Boston, Mass., pp. v + 524, pls. 12 and 405 text figures. The 1841 edition was soon out of print, and in 1865 the Legislature of Massachusetts directed a new and revised edition of this work to be published by Dr. Gould. In 1866, Dr. Gould, with the revision only partially completed, died. In 1867, the Legislature authorized the Governor and Council to appoint some person to complete the work, and W. G. Binney was chosen to do this task. The original copper plates could not be located, so the task fell to E. S. Morse to make a complete set of drawings on wood which composed the text figures. All of the plates but one are in color and these mainly showing nudibranchs and cephalopods. All of the figures on the plates as well as the text figures are numbered, continuing the numbers given in the first edition. The last figure in the first edition was no. 213, the first figure on the first plate in the second edition is no. 214 and ends on the last plate with fig. 349. The text figures start with no. 350 and end with no. 755.

Old as this work is, it still is our standard reference for New England, the names being modernized by C. W. Johnson's "Mollusca of New England" (1915) and his "List of Marine Mollusca of the Atlantic Coast from Labrador to Texas" (1934).

The first edition was concerned mainly with Massachusetts; the second edition was much broader in scope and dealt with nearly all of New England.

—W. J. CLENCH

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Published by
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Museum of Comparative Zoölogy, Harvard University
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TELLINIDAE

VOL. 4, NO. 45

THE SUBFAMILY TELLININAE IN THE WESTERN ATLANTIC THE GENUS *TELLINA* (PART I)¹

BY
KENNETH J. BOSS²

The primary purpose of this monographic study is to review the systematics of the genus *Tellina* and related genera in the Western Atlantic and to present a synthesis of the taxonomy of the group consonant with modern evolutionary theory. The first, and most important step in the realization of this purpose is the recognition and definition of each species. The criteria utilized in the determination of each taxonomic element have out of necessity been morphological. It is purposeful and valuable to study the relationships among the species and within the species-groups, a process which leads ultimately to an arrangement of superspecific categories, which, in their association, reflect the patterns of phylogeny. Along with the presentation of the results of the systematic investigation are the formulation and discernment of generalities concerning the patterns of geographical distribution.

ACKNOWLEDGMENTS

Without advice and aid from many persons and institutions, a work of this kind could never materialize, and therefore, to the following people, I would like to acknowledge my appreciation for their considerate help and cooperation. Dr. W. J. Clench, under whose direction most of this work was done, has read the manuscript and given freely of his time for constructive criticism. Dr. R. D. Turner and Miss V. C. Kenk have assisted in reading the text and in preparing some of the plates. Members and associates of the Department of Mollusks at Harvard University have served in various capacities and deserve many thanks; these include: Messrs. A. Merrill, R. W. Foster, R. I. Johnson and Miss M. L. Smith. Miss C. Martin, Mrs. B. Crowley and Mrs. M. Carrington have helped with the inking and preparation of the illustrations. Institutions and many private individuals have been helpful in the exchange and loan of specimens; these include: The Trustees of the British Museum (Natural History) and members of its staff, Messrs.

¹ The subfamily Tellininae will appear in 3 parts, as Johnsonia, number 45 [*Tellina* (Part I)]; number 46 [*Tellina* (Part II) and *Tellidora*], and number 47 [*Strigilla*]. The plates are numbered consecutively and some of those referred to in this number will be published in number 46.

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N. Tebble, P. Dance and C. P. Nuttall; Drs. H. Rehder and J. Rosewater of the United States National Museum; Drs. R. T. Abbott and R. Robertson of the Academy of Natural Sciences of Philadelphia; Mrs. G. Warmke of the Institute of Marine Biology of Puerto Rico; Dr. A. Clarke of the Canadian National Museum; Mr. P. Morris of the Peabody Museum of Yale University; Dr. E. Binder of the Muséum d'Histoire Naturelle in Geneva; Dr. J. Knudsen of the Universitetets Zoologiske Museum in København; Dr. C. O. van Regteren Altena of the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands; and, Messrs. A. A. Olsson, D. Schmidt, R. Parker, and R. Bullock. Financial aid from the Society of Sigma Xi and the Department of Biology, Harvard University, enabled the author to complete this study.

I would also like to acknowledge the aid of Mr. Kjell Sandved who photographed specimens, particularly for the last *Johnsonia*, number 44 on *Pandora*.

ABBREVIATIONS

ANSP	Academy of Natural Sciences of Philadelphia
BMNH	British Museum (Natural History)
CM	Charleston Museum
CNM	Canadian National Museum
IMBPR	Institute of Marine Biology of Puerto Rico
MCZ	Museum of Comparative Zoology, Harvard University
USNM	United States National Museum
ZMK	Universitetets Zoologiske Museum, København

HISTORICAL NOTE

The nominate genus *Tellina* dates from Linnaeus, but it was well established in the pre-Linnean literature. According to Jeffreys (1863), the generalized name, 'tellen', was introduced by Dioscorides of Anazarba in the first century. No doubt, the term had an even greater classical antiquity, since *Tellina* and its near relatives in the Tellinacea were held in high regard for economic reasons, particularly as food. In the Linnean definition of the genus, twenty-five species were included, of which nineteen remain in the confines of the Tellinidae as it is presently understood; the remaining species have been assigned to other groups. Hanley (1855) and Dodge (1952) have discussed the Linnean species and their relation to the Linnean conchological collection.

By the end of the 18th century, a number of additional species of *Tellina* had been described and Spengler (1798) had published the first treatise to deal solely with the genus. His work is valuable in that locality data are given for each species and that, by citation, the nonbinomial but important work of Chemnitz becomes available.

The first important monograph of the genus in the 19th century came with the work of Hanley (1846). In the *Thesaurus Conchyliorum*, Hanley delineated the known species of *Tellina* with little regard for subgeneric organization. The same may be said for the *Conchologica Iconica* of Reeve in which Sowerby (1869) treated the genus *Tellina*.

Römer (1870-73) produced a more exhaustive treatise on the Tellinidae and employed a conservative approach to the breakdown of the family into genera and subgenera. Later, Bertin (1878) discussed the family in general terms of zoogeography, elevated a number of subgeneric categories to the generic level, and delineated the known species preserved in the Muséum d'Histoire Naturelle, Paris. The fruition of these various labors

culminated in the works of Dall (1900a, b). His work still ranks as the most serious attempt to arrange the infrageneric groups in a meaningful scheme. More recently Afshar (1950), in an unpublished study of recent and fossil forms, has revised the generic and infrageneric taxa of the family.

Tryon (1869) and Paetel (1890) have catalogued the specific names in the family and Salisbury (1934) has delineated most of the superspecific categorical names. The best sources for type designations of superspecific groups include Schmidt (1818), Children (1823), Gray (1847), Kobelt (1878), Stoliczka (1870), and Dall (1900b).

Broad and general works dealing with the arrangement of subgenera and the placement of species include H. & A. Adams (1856), Fischer (1887), and Thiele (1935).

The early work of Say and Conrad provides a basis for the knowledge of the eastern American continental fauna and the descriptive treatises of d'Orbigny constitute the fundamental assessment of the Antillean and South American faunas. Dall (1900a) gave a synopsis of the North American species, and Dall and Simpson (1901) treated the Puerto Rican forms. Recently, Warmke and Abbott (1961) have reviewed in general terms the species of the Caribbean. Numerous smaller but no less significant works have dealt with more restricted geographical areas.

The fossil history of the Tellininae in the Western Atlantic has been largely revealed through the work of Dall (1900b), Woodring (1925), Maury (1917; 1920) and Gardner (1928). In the general discussion for each taxon in the present work, pertinent remarks are made concerning the fossil record.

The basis of the faunal comparison between the tellini-form species of the Western Atlantic with that of the Eastern Pacific rests on the rather extensive literature on the bivalves of the Panamic Province. Dall (1900a) described a number of species from the Eastern Pacific and listed the occurrence and range of each. Hertlein and Strong (1949) and Keen (1958) have contributed greatly to the knowledge of the Eastern Pacific fauna, and Olsson (1961) has summarized the work of the early writers and presented a well illustrated and monographic treatment of the bivalves of that area.

SHELL MORPHOLOGY

The morphological characters of the shell are of great importance in the systematics of the Tellinidae (Plate 127). In a great measure, some of the most distinctive anatomical features are reflected in conchological characteristics so that great reliance upon 'hard-part' morphology is justified. In general, the higher categories in bivalve mollusks are determined to some extent upon the structural nature of the hinge and ligamental mechanisms; however, the number and placement of muscle scars and the structural nature of the ctenidia are also very important. At the generic and subgeneric levels in the Tellinidae, the most important traits include: 1, the structure, placement, and strength of the dentition of the hinge; 2, the configuration of the pallial sinus and its relationship to the pallial line and the adductor muscles; 3, the placement, extent, and development of the ligament; and 4, the peculiarities of external sculptural differentiation. In addition, the shape and size of the shell as well as its external and internal coloration have some measures of validity in the delineation of taxa.

The hinge of the Tellinidae always possesses two cardinal teeth, which are referred to as constituting the cardinal complex. These structures which rest upon a variously thick-

ened lateral or cardinal plate are situated beneath the umbo and serve to interlock the valves. At least one of the two cardinal teeth in each valve is bifurcate and is herein referred to as the bifid cardinal tooth; the other is generally a single structure and is herein called the laminate cardinal tooth. In the left valve, the bifid cardinal tooth is always in the anterior position while the laminate cardinal is posterior. The configuration of the cardinal complex in the right valve is reversed; the bifid cardinal is posterior and the laminate cardinal is anterior. The cardinal teeth exhibit but a small range of variation from species to species and are therefore of little use for specific identification. However, the lobes of the bifid cardinal are of variable size and they may be skewed from the dorso-ventral axis of the shell, in which case they assume some taxonomic importance. Likewise, the thickness and length of the laminate cardinal may function in the discrimination of species.

The presence of lateral teeth distinguishes the Tellininae from the Macominae, which are laterally edentate. The lateral teeth in the Tellininae are differentiated projections

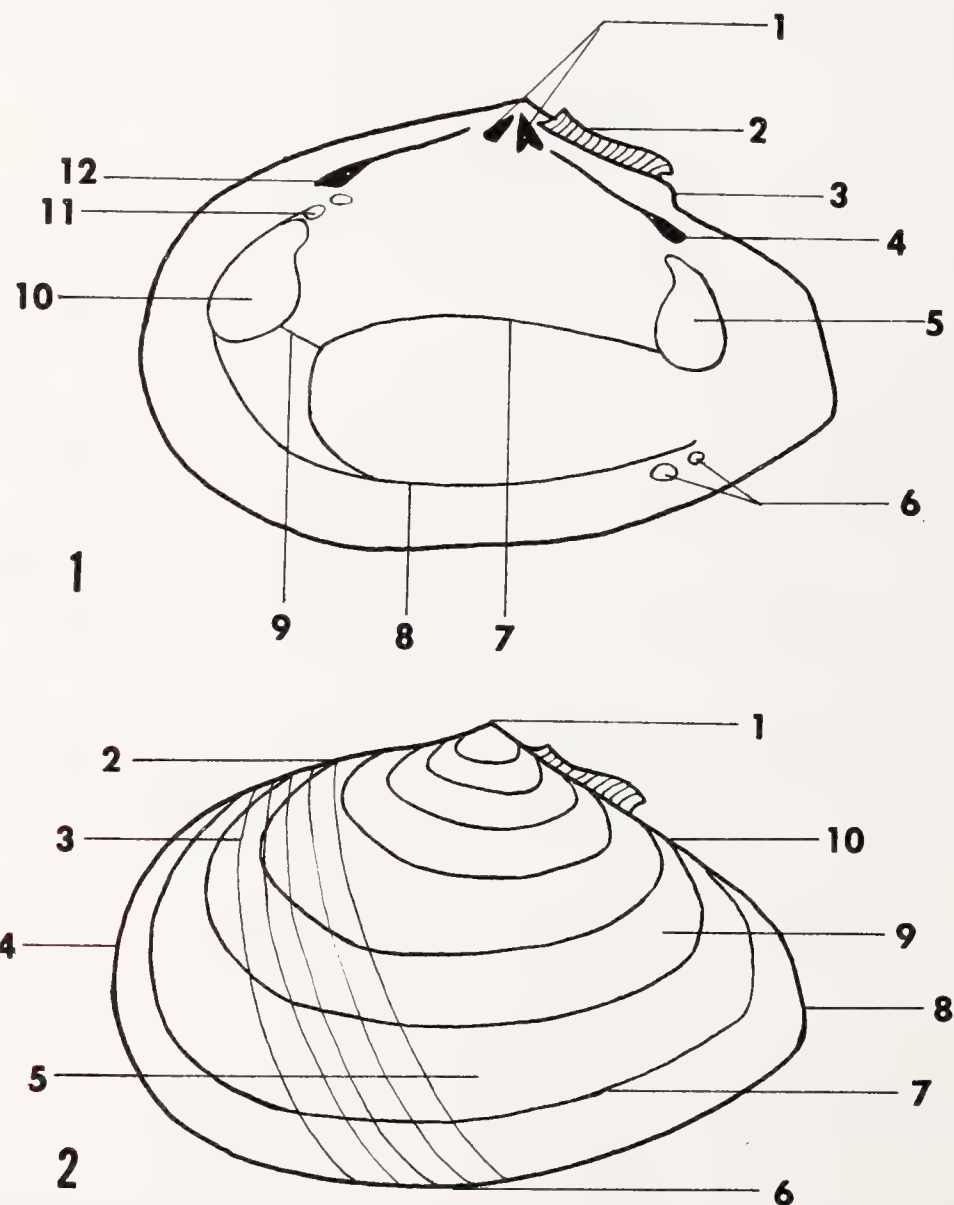


Plate 127. Diagrammatic representation of the shell morphology of a generalized *Tellina*. Fig. 1. Internal view of a right valve. 1. Cardinal complex with the single anterior laminate cardinal tooth and the bifid cardinal tooth. 2. Ligament. 3. Nymphal callosity. 4. Posterior lateral tooth. 5. Posterior adductor muscle scar. 6. Cruciform muscle scars. 7. Pallial sinus. 8. Pallial line. 9. Interlinear scar. 10. Anterior adductor scar. 11. Pedal retractor scars. 12. Anterior lateral tooth. Fig. 2. External view of a left valve. 1. Umbo. 2. Anterior dorsal margin. 3. Oblique sulcus or scissulation. 4. Anterior margin. 5. Disc. 6. Ventral margin. 7. Concentric sculpture. 8. Posterior margin. 9. Posterior slope. 10. Posterior dorsal margin.

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of the hinge line and interlock as well as stabilize the position of the two opposite valves. The maximum number of laterals is four, that is, two in each valve. The one behind the cardinal complex in the vicinity of the end of the ligament is called the posterior lateral, the other in front of the cardinal complex is the anterior lateral. In the left valve, the lateral dentition is less strongly developed than in the right valve. In most groups the right valve possesses the greatest development of the lateral teeth and, in particular, it is the right anterior lateral tooth which maintains the greatest strength while often the posterior lateral is diminished. Sockets or fossae for the interlocking of the teeth in opposite valves are sometimes developed. The position of the right anterior lateral tooth assumes some importance as a taxonomic character because it is variously placed in relation to the cardinal complex. In groups like *Eurytellina* and *Angulus*, this tooth is proximal to the cardinal complex whereas in *Tellina* s.s. and in *Tellinella*, the tooth is distal to the cardinal complex.

The ligament is opisthodontic or posterior to the umbos and mostly external. It consists of a horny external sheath which is yellow, brown, or black in color and of an internal, fibrous, calcareous element which is white. The nymph subtends the calcareous element of the ligament and consists of a thickened portion of the dorsum of the shell. When the nymphs are greatly thickened and protuberant, they are termed nymphal callosities. Trueman (1949) has discussed the structure of the ligament in *Tellina tenuis* in great detail.

The form of the ligament varies from the extremely long and narrow, as in *Phylloda*, to the short and high, as exemplified by *Angulus*. The nymphal callosities tend to be better developed in thin shells with a short ligament, and in the main, suborbicular species have a short ligament. In *Tellidora*, there is a tendency for the ligament with its calcareous element to become internal, as in the related family Semelidae.

The internal surface of each valve bears a number of muscle scars which delimit the attachment of muscles to the shell. Plate 127 illustrates these muscle impressions and their associated structures. The anterior adductor muscle tends to be long and narrow while the posterior adductor is more or less rounded to subquadrate. Dorsal to the adductors are the scars of the pedal musculature; the anterior pedal retractor impresses the greatest complex of scars along the anterior dorsal border of the shell and may, in fact, be largely confluent with the anterior adductor muscle. From the base of the posterior adductor the pallial sinus takes its origin. The siphonal musculature forms the scar of the definitive pallial sinus which extends anteriorly and which may or may not be confluent with the anterior adductor muscle. Ventrally the pallial sinus usually unites with the pallial line. If the pallial sinus does not touch or become confluent with the anterior adductor muscle scar, the distance which separates them may be traversed by a linear scar. In many cases the linear scar is absent and no direct connection exists between the sinus and the anterior adductor. Far posteriorly and closely aligned to the terminus of the pallial line are the cruciform muscle scars. These are four in number, two for each valve. In general, the scars are rounded, but the anterior one in the right valve tends to be rectangular.

The microscopic structure of the shell has been described by Trueman (1942). The periostracum is made up of a horny substance. The calcareous portion of the shell is aragonitic and divided into three layers of different crystallographic properties.

The external sculpture is predominantly concentric. Sulci of varying strength gener-

ally separate the broad concentric bands or narrower raised lirations. Dorsally the concentric sculpture may become differentiated into spinosities, particularly along the posterior slope. Radial sculpture is rare and in no case does it occur alone; therefore, a number of species present a pattern of cancellate sculpture. Acentric sculpture consisting of oblique sulci which cross the rectangular concentric sculpture is typical of a number of tellinid groups, particularly *Scissula* and *Strigilla*. This pattern of sculpture is herein referred to as being scissulate, and the oblique sulci are termed scissulations.

The sculptural pattern and thickness of the valves are adaptive characteristics which may be correlated with environment. Heavily shelled species, such as the European *Tellina crassa*, are found in substrates of coarse sand and shelly gravel whereas the thinly shelled species, such as *Tellina agilis*, occur in muddy sands. The sculptural pattern may be responsible for the maintenance of position in the substrate. Some *Tellina* live vertically whereas *Macoma*, which rarely tends to be sculptured, lies on its side in a horizontal position. Unfortunately, a quantitative evaluation of the adaptive significance of these characteristics is lacking.

ANATOMY

The following discussion is based largely on dissections of *Tellina alternata* Say and *Tellina punicea* Gmelin, both representatives of *Eurytellina*. These dissections were, except from minor portions, executed by Miss Vida C. Kenk of the Department of Mollusks, Museum of Comparative Zoology, Harvard University. Many of the statements concerning specific morphological traits have been derived from the literature. The European species, particularly the British species, of *Tellina* are best known from the morphological works of Atkins, Graham, and Yonge. Pelseneer laid the foundation for some comparative work on the species of the East Indies in his general discussion of pelecypod morphology in the Siboga report (1911). The anatomical features which are discussed below are illustrated on Plate 128.

Mantle. The mantle is thin and transparent. It is united dorsally and fused postero-ventrally in the region of the cruciform muscle where it is thickened at its edge. The pedal gape is large and extends ventrally from the anterior adductor muscle to the cruciform muscle. Posteriorly the mantle is modified to form portions of the siphonal apparatus and musculature.

Foot. The foot is large, generally laterally compressed and quite active. Yonge (1949) has described its great mobility and usefulness in burrowing. Pelseneer (1911) has shown that some species develop a plantar surface on the foot. The vestigial pedal gland and remnants of the byssiferous apparatus have been studied in detail by Carriere (1879) and Barrois (1885). A functional byssus is absent in the adult stage.

Musculature. The morphology of the musculature has been reviewed by Graham (1934b) who made a comparative study of the myology of selected members of the Tellinidae and related families. The anterior and posterior adductors are large and well developed. The anterior adductor is subdivided into two or three parts, the largest of which is ventral; the muscle tends to be irregularly elongate and semilunate in shape. The posterior adductor tends, on the other hand, to be more or less quadrate. A medial adductor courses through the viscera in the vicinity of the appendix of the stomach and is

attached to both valves anterior to the cardinal complex in the umbonal cavity. The extrinsic pedal musculature consists of anterior and posterior pedal retractors and of a pedal protractor; the entire complex of pedal musculature inserts into the foot. The narrow origin of the protractor pedis is immediately dorsal to the largest portion of the anterior adductor muscle and ventral to the origin of the anterior pedal retractor. The protractor splays out superficially over the foot.

The anterior pedal retractor which is generally separated from the protractor pedis by a small division of the anterior adductor muscle, forms a trigonal attachment along the anterior dorsal margin. The anterior retractor inserts deeply into the foot, lies under the protractor pedis fibers and portions of the posterior retractor although some of its fibers lie over those of the posterior retractor. Another section or portion of the anterior adductor is present along the anterior dorsal margin above the origins of the anterior pedal retractor. There are no elevator pedis muscles.

The posterior pedal retractor makes an oval attachment dorsal to the posterior adductor muscle along the posterior dorsal margin of the valve. This pedal muscle courses anteriorly through parts of the kidney into the foot where its fibers lie beneath the superficial fibers of the pedal protractor and intermesh with the fibers of the anterior pedal retractor.

The foot and viscera possess many intrinsic adductor muscle fibers while special siphonal muscles and the cruciform muscles are developed posteriorly. The pallial muscle defines the size and placement of the pallial sinus or cavity and generally is coextensive with the

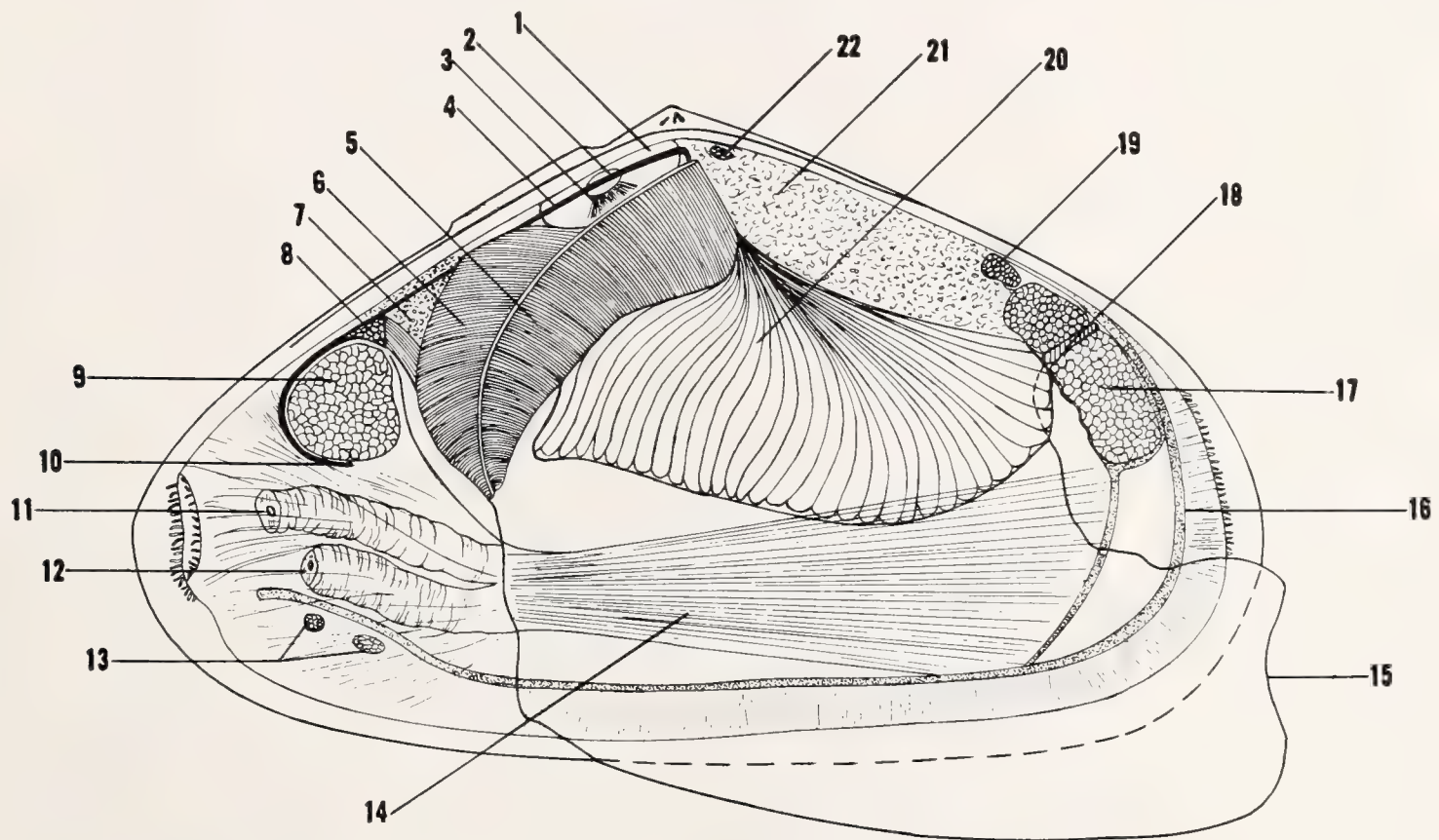


Plate 128. Semidiagrammatic illustration of the anatomy of *Tellina* (*Eurytellina*). Fig. 1. Specimen with the right valve removed to show general structural features. 1. Pericardium. 2. Ventricle. 3. Auricle. 4. Rectum. 5. Inner demibranch. 6. Outer demibranch. 7. Kidney. 8. Posterior retractor muscle. 9. Posterior adductor muscle. 10. Anus. 11. Excurrent siphon. 12. Incurrent siphon. 13. Cruciform muscles. 14. Siphonal retractor muscle. 15. Foot. 16. Pallial muscle. 17. Anterior adductor muscle. 18. Pedal protractor muscle. 19. Posterior retractor muscle. 20. Labial palps. 21. Digestive gland. 22. Medial adductor muscle.

muscular lobes of the mantle ventrally. A short supportive interlinear muscle may connect the anteriormost extension of the pallial muscle with the anterior adductor muscle.

Cruciform muscle. The posterior portion of *Tellina* is highly specialized. The cruciform muscle, a structure found only in the Tellinacea (see Graham, 1934a, b; Yonge, 1949), possesses a sensory pit and associated sensory structures as well as the uniquely crossed muscles. Deshayes (1848) pictured the muscle and its concomitant scars which are impressed on the shell. Von Ihering (1901) proposed that the muscle acted as an additional adductor and Graham (1934a) proposed the notion that the muscle and its associated sensory structures were used for water testing. Hoffman (1914) suggested that this sense organ in *Tagelus* functions in the perception and the regulation of blood-pressures in the neighborhood of the siphons. Yonge (1949) agreed with Graham (1934a) that the contention of von Ihering is hardly feasible but disagreed with Graham in pointing out that *Tellina* live deep in the substrate and that water detection would hardly serve a useful purpose, inasmuch as the siphons bring in water from the substrate, at least twenty centimeters away. It might further be suggested that a chemoreceptor is probably present in the structure of the siphonal organ and that an additional organ serving a similar purpose is hardly necessary. Yonge contends that the function of the cruciform muscle and organs is one of proprioception. The muscles themselves acting as a supportive structure for the highly extensile siphons and the sensory pit informing the animal of the relative position of the siphons. He argues that the siphons which are very large must be retracted before the mollusk can move with its foot. Since the movement of these structures is probably not a simultaneous one, the cruciform organ may serve to inform the animal about the conditions of blood pressure. It is of interest to note that the siphons of *Macoma* may be found 'swimming' over the substrate, after having been clipped by the edge of the valves during a quick closure.

According to Graham (1934a), *Tellina* and *Macoma* may be differentiated by the nature of the sensory pit associated with the cruciform muscle. In *Macoma*, the pit is connected to the environment by means of a narrow, short tube whereas in *Tellina* it is directly in contact with the external medium.

Siphonal and parasiphonal organs. Another complex of structures is associated with the incurrent siphon. These include the unilateral siphonal and paired parasiphonal organs. They were shown in *Tellina nitida* by Deshayes (1848), and were depicted in *Tellina planata* by Poli (1795), although he did not specifically mention them. Pelseneer (1911) noted the 'organe sensoriel siphonal' or 'valvule palleale' in *Tellina carnicolor* and *T. pretiosa*. Yonge (1949) discussed them as the mantle folds in the Tellinacea and compared them with similar structures in the Mactracea. The same structures in *Temnoconcha* have been illustrated by Boss and Kenk (1964). It is probable that the paired parasiphonal organs are used to keep pseudofaeces from being swept into the gill by the forceful incoming current, to act as valves covering the aperture of the incurrent siphon, and to direct the incoming particles to the distal portions of the ctenidia. The unique siphonal organ is probably associated with the detection of the quality of inflowing water. Both structures appear to be well innervated and a small ganglion is present in the tissues of the siphonal apparatus.

Ctenidia and palps. The ctenidia and the labial palps are the most conspicuous organs in the mantle cavity. Generally the palps are smaller than the ctenidia in *Tellina* while

the reverse situation may obtain in *Macoma*, although there are exceptions. The exact proportional relationship between palp size and ctenidial size may be an environmental corollary associated with substrate. The palps are plicate and generally somewhat trigonal in shape. They may be folded somewhat in the mantle cavity so that particular grooves are developed which lead to the mouth, and they are generally contiguous with the anterior boundary of the inner demibranch along a line which has been called the 'distal oral groove' (Kellogg, 1915; Graham, 1937).

The structure of the gills in the Tellinidae has been summarized by Ridewood (1903). The gill is unique. Its anterior portion lacks the outer demibranch and the inner demibranch alone extends dorsally and superficially over part of the pericardium. Centrally and along most of the ctenidial length, the outer demibranch is present and consists of a single dorsally upturned direct lamella. Posteriorly and distally, the lamella of the outer demibranch infolds to form a downwardly-directed portion. The lamellae of both demibranchs are flat and homorhabdic.

The ciliation of the gills has been discussed and described by Kellogg (1915) for *Macoma secta*, Graham (1937) for *Tellina crassa* and Atkins (1937a, b) for *Tellina donacina*, *T. fabula*, *T. tenuis*, *T. crassa*, and *Macoma balthica*. Yonge (1949) corroborated the findings of Atkins. In most species, food particles are carried across the inner demibranch in an antero-ventral direction in the ventral food groove to the labial palps and thence to the mouth. Specific differences, including the presence of supplementary food groove and alterations in kinds of ciliation are recorded by Atkins (1937b). By means of ciliary currents in the mantle cavity, pseudofaeces are collected ventrally at the siphonal organs and are expelled through the incurrent siphon. As Yonge (1949) noted, the sand grains expelled with the pseudofaeces are the largest taken into the mantle cavity; smaller grains enter into the digestive system.

Alimentary canal. The structure of the alimentary canal was figured by Deshayes (1848) for *Tellina nitida*. The functional and adaptive significance of the morphology of the digestive system has been illuminated by the work of Graham (1949), Yonge (1949), Owen (1955) and Purchon (1960). The relatively long, straight oesophagus enters the stomach anteriorly. The stomach consists of a medial globular portion and a postero-ventral extension, the style sac, which is typically united with the midgut. The style sac contains a large crystalline style which abrades against a well developed gastric shield located dorsally in the globular portion of the stomach. This latter portion of the stomach is invested with a complex of ciliated grooves and ridges which direct particulate matter into or out of the caeca of the stomach. Graham (1949) in his description of *Tellina crassa* identified right and left caeca which are antero-ventral and which are coextensive with the right and left lobes of the digestive gland, via a specific number of ducts. In addition, he described a dorsal pouch which is not connected with the digestive gland. The dorsal caecum is however in some species provided with connections to the left lobe of the digestive diverticula. Yonge (1949) added the postero-dorsal or posterior caecum which Purchon (1960) mercifully proposed to call the appendix, relieving the already congested vocabulary. This latter structure, the appendix, was overlooked by Graham (1949). Beneath the appendix courses the previously mentioned medial adductor muscle. As explained by Yonge (1949), the appendix serves as the receptacle for intermediate sized sand grains which are later triturated by the action of the revolving crystalline

style. Sand grains found in the compacted faeces, or faecal pellets, in the ascending portions of the midgut and posteriorly, are of a smaller size. With regard to the size and extent of the appendix, Yonge (1949) found that *Macoma balthica* possessed an unusually large structure filled with sand grains. Such an observation is comparable to conditions in *Macoma secta* as reported by Kellogg (1915), who found large quantities of sand in the intestine of this species.

The right and left caeca are connected by the major typhlosole and its concomitant intestinal groove. According to Yonge (1949), the dorsal caecum is connected via the proximal groove with the right or 'food sorting' caecum. The precise movement of materials into, out of, and between each caecum, as well as along the proximal and intestinal grooves is complex and still not fully explained and described. It is sufficient to say that sorted material of small size enters the respective caeca and from there is taken into the branching tubes and pouches of the digestive diverticula where intracellular digestion occurs. All three of the caeca may possess ducts connecting with the digestive gland. The occurrence of phagocytosis and other phenomena associated with movement of particles and digestion in the digestive diverticula have been discussed by Owen (1955). It must be remembered that extracellular digestion is instigated by the enzymes of the crystalline style and that the digestive diverticula, even though associated with the caeca may also connect directly with the globular portion of the stomach itself.

The midgut, combined with the style sac proximally arises independently in an ascending portion before going through a number of complex convolutions. Distally in the ascending portion, faecal pellets are formed. Yonge (1949) and Moore (1930; 1931) have discussed the size, shape and consolidation of the pellets in relation to the midgut length. In this regard, it is important to note that the complex convolutions of the midgut are greater in such species as *Macoma balthica* than they are in *Tellina tenuis*. This is another possible generic distinction first noted by Graham (1934b) and correlated by Yonge (1949) with the intake of mud.

Purchon (1960) has aptly summed up the structural features of the stomach of the Tellinidae in his comprehensive and analytic discussion of the 'Stomach Type V' in the Eulamellibranchia. In short, the major features include: 1) an oesophagus which enters the stomach anteriorly; 2) a union of the style sac with a portion of the midgut; 3) a crystalline style which projects into the stomach and revolves upon the shield on the entad surface of the dorsum of the stomach; 4) a minor and major typhlosole; 5) a left dorsal anterior pouch or caecum; and, 6) a number of specific sorting areas.

The midgut nominally terminates with the beginning of the rectum at its entrance into the pericardium. The rectum traverses the ventricle, passes out the pericardium, continues around the dorsal and ectad surface of the posterior adductor muscle to terminate in an anus near the opening of the excurrent siphon.

The reno-pericardial structures. The heart in *Tellina* is of a simple form. The pericardium is located dorsally between the kidney and the digestive diverticula and may be superficially covered by the dorsal extension of the inner demibranch. The heart itself consists of two large, laterally paired, thin-walled auricles connecting with a single medial, muscular ventricle which is traversed by the rectum. Dorsal aortae extend anteriorly and posteriorly from the ventricle. Deshayes (1848) has discussed in considerable detail the ramifications of the vascular system in *Tellina nitida*. White (1942) has re-

ported the presence of glandular matter in the mantle of *Tellina crassa* which was taken to be the remnants of the pericardial gland. The pericardial organs do not appear to be very well developed in *Tellina*. The pericardium is coextensive with the kidney by means of the paired ciliated funnels.

Odhner (1912) has discussed the reno-pericardial structures in the Tellinidae; his descriptions are based on the anatomy and histology of *Tellina* [*Macoma*] *balthica* and *Scrobicularia nitida* [which is presently referable to the Semelidae]. The gross anatomy of the macomoid *Temnoconcha* has been discussed by Boss and Kenk (1964). In *Tellina alternata* and *T. punicea*, the kidney and its associated structures are essentially alike and do not depart from the general structural features as described by Odhner.

The kidney lies between the heart and the posterior adductor muscle and is traversed by portions of the posterior pedal retractor. As in *Gari tellinella* (Graham, 1934b), the right and left kidneys are united medially, putting them into broad communication. Paired ciliated funnels connect the cavity of the pericardium with the central and proximal portions of the kidney. The nephroproct empties into the urogenital sinus, a common cavity into which the gametes are also released.

Nervous system. The structure of the nervous system conforms to the usual pattern of the lamellibranchs and is quite similar in its general aspects to that of *Psammobia vespertinalis* (Duvernoy, 1853) and *Gari tellinella* (Graham, 1934b). Paired cerebropleural ganglia are located anterior to the fusion of the labial palps on the entad surface of the anterior adductor muscle. These ganglia, which are united by a thin dorsal commissure, give rise to the anterior pallial nerves which course over the external surface of the anterior adductor muscle and innervate the pallial muscles of the mantle and to a short ramus which enters the anterior adductor muscle directly. Individual medially directed rami enter the labial palps. Extending postero-ventrally from the cerebropleural ganglia are the cerebropleural pedal connectives which lead to the closely juxtaposed pedal ganglia in the foot. The presence of otoliths has been indicated for an unidentified *Tellina* by von Ihering (1876) and for *Tellina assimilis* and *T. fabula* by Pelseneer (1911). The pedal ganglia also send out branches which innervate the intrinsic muscles of the foot, certain portions of the alimentary canal, the digestive diverticula and the pedal retractors. Extending posteriorly from the cerebropleural ganglia are the cerebropleural-visceral connectives which communicate with the developed, large and partially united visceral ganglia. Running antero-dorsally from the visceral ganglia are the branchial nerves which ramify in the ctenidia. A small anterior nerve enters the kidney. A distinct ramus innervates the posterior adductor muscle and forms the dorsal pallial nerve. A large ventral ramus descends from the visceral ganglion to divide into a number of subsidiary rami which serve the various organs associated with the siphonal apparatus. The development of the nerves of the ventral ramus is complex. There is a divided ramus for the siphonal retractor muscles, another branch which divides sending a ramus into the cruciform muscles and another into the siphonal organs. Still another major nerve divides to enter the incurrent and excurrent siphons.

Reproduction. *Tellina* is dioecious. The gonad is imbedded in the foot and surrounds much of the style sac and midgut, extending dorsally and posteriorly in the viscera to the pericardium. The oviduct or vas deferens debouches reproductive products in the common urogenital sinus (Odhner, 1912).

The time of spawning appears to vary by species and geographical locality. Sullivan (1948) found that larval *Tellina agilis* were available at Prince Edward Island, Canada, from July to August while Odhner (1914) found that certain Adriatic *Tellina* have a fifteen day pelagic stage in mid-May. Lovén (1848) has pictured the young stages of an unidentified *Tellina* and Rees (1950) noted the taxodont dentition of the provinculum and the early development of the cardinal dentition. The settling spat of *Tellina* appear to be brightly colored, particularly with purple umbonally.

The pelagic larval stage and its length permit the distribution of species by currents. Those species with a greater range probably have longer larval periods whereas those with shorter pelagic stages may tend to have a restricted distribution. The substrate specificity for settling larvae has never been investigated, but the specificity exhibited by the adults can be used as a criterion in the interpretation of barriers to distribution. Impenetrable substrata are totally unsuitable and most species are adapted to the sand or mud habitat. Rocky coasts, coral reefs, or hard-packed sand are unsuitable habitats and may serve as minor features in the isolation of populations. Unfortunately, the state of the present knowledge of the period of larval development in the Tellininae is so poor that statements as to the relationship between range and length of pelagic stage can only be inferential.

ZOOGEOGRAPHICAL CONSIDERATIONS

Table I summarizes the distributional data for the subfamily Tellininae in the Western Atlantic. Tables II and III present a delineation of the patterns of allopatry in species-groups between the Western Atlantic and the Eastern Pacific and within the Western Atlantic.

Excepting *Acorylus*, all the Western Atlantic superspecific groups are polytypic. Groups of species representing each generic or subgeneric category are represented in the fauna of the Eastern Pacific or the Indo-Pacific. In general, it may be said that those groups poorly represented in the Western Atlantic are well developed in the Eastern Pacific and, vice versa. Thus, *Tellinella*, represented by *T. listeri* in the Western Atlantic and *T. cumingii* and *T. zaca* in the Eastern Pacific, has numerous representatives in the Indo-Pacific. Similarly, *Angulus* and *Eurytellina*, as herein defined, are very richly developed in the Western Atlantic and Eastern Pacific, but not as highly differentiated in the Indo-Pacific. Western Atlantic species are clearly more closely allied to those of the Indo-Pacific than to either the Eastern Atlantic or the Mediterranean; however, a number of groups well represented in the Indo-Pacific are not present in the Western Atlantic.

When a comparison of superspecific categories is made for the Western Atlantic and the Eastern Pacific, only three of the Western Atlantic groups are absent from the Eastern Pacific. *Tellina* s.s., *Arcopagia*, and *Acorylus*, mostly large and conspicuous elements of the Western Atlantic fauna, do not occur in the Eastern Pacific. The large and polytypic subgenera, *Eurytellina* and *Scissula* are nevertheless less well developed in the Western Atlantic, whereas *Angulus* appears to be more or less equally well developed in both areas.

Numerous authors have proposed faunal provinces for the Western Atlantic Ocean. Ekman (1953) discussed the problem in general zoogeographical terms. Much of his information regarding the distribution of mollusks is derived from von Ihering (1907;

1927). In a recent review, Coomans (1962) has summarized the faunal provinces of the Atlantic coast of continental North America with particular reference to the Virginian Subprovince. The following scheme is employed herein. Six provinces and five sub-provinces are adopted. The Arctic Province extending from the polar area to Newfoundland has no representative of the subfamily Tellininae and is therefore beyond the scope of the present discussion. The Nova Scotian Province is boreal and extends from Newfoundland to Cape Cod. The Carolinian Province extends from Cape Cod to Eastern Florida in the vicinity of Cape Canaveral (=Cape Kennedy) and thence to the Gulf of Mexico from Cape Sable, Florida, to the vicinity of Veracruz, Mexico. The West Indian or Antillean Province is bounded by Cape Canaveral (=Cape Kennedy) and Key West, Florida, and the Golfo de Campeche near Veracruz in the north and extends south to Brasil. It may be divided into the Caribbean Subprovince which includes some of the Gulf of Mexico and the Caribbean Sea and is bounded on the south by Trinidad and the Gulf of Paria. The Brazilian Subprovince extends south of the Tropic of Capricorn to Santa Catharina. The Argentinian Province extends from southern Brasil to the Golfo de San Jorge, Argentina. South of the Argentinian Province is the Magellanic Province which because of a lack of representatives of the subfamily is omitted from the discussion.

The distributional data presented in Table I shows that only a single species, *T. agilis*, may be considered boreal while the remaining number of species are temperate, subtropical, or tropical. Thus, it is justifiably observed that the subfamily is predominantly Antillean or West Indian, for, excluding *agilis*, only two species, *T. versicolor* and *T. tenella*, normally occur in the Virginian Subprovince as far north as Cape Cod. Cape Hatteras is a geographic feature which demarcates the northernmost range for fourteen species, five of which are probably advectitious to the offshore shallows at Cape Hatteras. These include *T. listeri*, *laevigata*, *fausta*, *squamifera*, and *americana*. The presence of small and immature individuals actually constitute the records for these species in the north and indicate the absence of an adult breeding population. It is most probable that the larvae of these species have been transported from the south by the currents of the Gulf Stream. The same may be said for the records of *T. radiata* and *T. cristallina* in South Carolina. North of Cape Canaveral (=Cape Kennedy) and in the vicinity of Saint Augustine, two species, *T. lineata* and *T. tampaensis* have their northernmost range extension. The area near Lake Worth, Palm Beach, and Miami serves as a point of delimitation of the range of some twelve species in addition to the eight which advectitiously extend to the Carolinas. This area marks for the Tellininae the beginning of the Antillean fauna. Only six species are more or less limited to continental North America.

Over forty-five species of the Western Atlantic Tellininae are distributed in the Antillean Province, and of these, six possess distributions restricted to the Antilles. The remaining species are more widely ranging. The South American fauna, on the East coast of South America from the Guianas to Argentina possesses nineteen species, and of this number only five are endemic. Three of the endemics are strictly southern temperate in their range and are found in the Argentinian Province while the other two are represented by the very poorly known species, *T. brasiliiana* and *T. alerta*. The other fourteen South American species are in the Brazilian Subprovince and are all related and derived from the Antillean fauna. Among certain of the latter, some divergences are apparent between northern and southern populations corresponding roughly to populations of Caribbean and Brazilian Subprovinces.

A tally of the number of species geographically shows that the lesser Antilles with thirty-three species is the richest area while southern Florida is next in richness with thirty species. Each of the Greater Antilles has a fauna nearly the same size numerically.

TABLE I. Distribution of the species of the Tellinidae in the Western Atlantic Ocean.

	Northernmost record	N of Cape Cod	S of Cape Cod-Va.	North Carolina	South Carolina	Georgia	Florida (East)	Florida (South)	Florida (West)	Gulf Coast	Mexico	Central America	Bermuda	Bahama Islands	Cuba	Jamaica	Hispaniola	Puerto Rico	Virgin Islands	Lesser Antilles	Colombia	Venezuela	Guianas	Brasil	Uruguay	Argentina	Southernmost record
<i>radiata</i>	South Carolina																										British Guiana
<i>brasiliensis</i>	---																										Brasil
<i>iheringi</i>	Mar del Plata																										San Matias, Argentina
<i>petitiensis</i>	Sao Thome, Brasil																										San Matias, Argentina
<i>listeri</i>	off Cape Lookout, N.C.																										N of Bahia, Brasil
<i>laevigata</i>	Beaufort, N.C.																										La Guayra, Venezuela
<i>magna</i>	Fort Walton, Fla.																										Martinique, West Indies
<i>fausta</i>	Cape Lookout, N.C.																										Aruba, off Venezuela
<i>squamifera</i>	Cape Hatteras, N.C.																										Dry Tortugas, Fla.
<i>persica</i>	Matanzas, Cuba																										Tobago, West Indies
<i>americana</i>	Cape Lookout, N.C.																										Barbados, West Indies
<i>crystallina</i>	Sullivan's Id., S.C.																										Margarita Id., Venezuela
<i>aequistriata</i>	off Beaufort, N.C.																										off Bahia, Brasil
<i>alerta</i>	---																										type locality only
<i>martinicensis</i>	Tampa, Fla.																										Tobago, West Indies
<i>juttingae</i>	Trinidad																										Surinam
<i>gouldii</i>	Palm Beach, Fla.																										Margarita Id., Venezuela
<i>angulosa</i>	Biscayne Bay, Fla.																										Canelones, Uruguay
<i>alternata</i>	Cape Hatteras, N.C.																										Florida Keys
<i>tayloriana</i>	---																										Texas
<i>trinitatis</i>	Marco, Fla.																										Canelones, Uruguay
<i>punica</i>	Belize, B.H.																										Sao Francisco, Brasil
<i>nitens</i>	Cape Hatteras, N.C.																										Tobago, West Indies
<i>gouldingii</i>	Bermuda																										Barbados, West Indies
<i>lineata</i>	St. Augustine, Fla.																										Sao Sebastian, Brasil
<i>vespuciana</i>	off Texas																										Trinidad
<i>mera</i>	Lake Worth, Fla.																										Curacao, West Indies
<i>paramera</i>	Miami, Fla.																										Barbados, West Indies
<i>tampaensis</i>	Mosquito Lagoon, Fla.																										Aquin, Haiti
<i>colorata</i>	St. Thomas, Virgin Ids.																										Guadeloupe, West Indies
<i>agilis</i>	St. Lawrence R., Canada																										Sapelo Id., Georgia
<i>texana</i>	Beaufort, N.C.																										Bahia Honda, Cuba
<i>versicolor</i>	Sakonnet, R.I.																										Gulf of Paria, Trinidad
<i>exerythra</i>	Portland Bight, Jamaica																										Brasil
<i>probrina</i>	Miami, Fla.																										Tobago, West Indies
<i>diantha</i>	Barbados, West Indies																										Rio de Janeiro, Brasil
<i>euvitrea</i>	St. Lucia, Cuba																										Ponce, Puerto Rico
<i>tenella</i>	Wareham, Mass.																										Horn Id., Mississippi
<i>sybaritica</i>	Beaufort, N.C.																										Bahia, Brasil
<i>gibber</i>	La Paloma Rocha, Uruguay																										San Matias, Argentina
<i>similis</i>	Isle of Palms, S.C.																										Barbados, West Indies
<i>iris</i>	Cape Hatteras, N.C.																										Miami, Fla.
<i>consobrina</i>	Miami, Fla.																										Tobago, West Indies
<i>sandix</i>	Jamaica																										La Paloma Rocha, Uruguay
<i>candeana</i>	Palm Beach, Fla.																										Guadeloupe, West Indies
<i>carnaria</i>	Miami, Fla.																										Mar del Plata, Uruguay
<i>pseudocarnaria</i>	Jamaica																										Guanta, Venezuelas
<i>pisiformis</i>	Bimini, Bahamas																										Sao Francisco, Brasil
<i>mirabilis</i>	Cape Hatteras, N.C.																										Grenada, West Indies
<i>gabbi</i>	Key West, Fla.																										Recife, Brasil
<i>producta</i>	Jamaica																										Barra Secca, Brasil
<i>cristata</i>	Beaufort, N.C.																										Progreso, Yucatan

Hispaniola and Cuba have twenty-six species. The smaller islands of Jamaica and Puerto Rico each has twenty-two species. Further, it may be remarked that Bermuda has received its thirteen species from the Antillean fauna. In the pattern of distribution for the subfamily, it can be seen that there is an area of concentration in the Antilles and a gradual diminution to the north and south. North America has a richer fauna than South America and the elements of the South American fauna are predominantly Antillean. Such a distribution pattern is analogous to that reported for other molluscan and invertebrate groups (Ekman, 1953).

The information accrued from an analysis of the distribution of each species in the subfamily is presented in Tables II and III. It can be seen that patterns of distribution are indicative of the importance of geographic isolation upon the formation of species. Of the fifty-two Western Atlantic species, twenty-six are represented by analogous species in the Eastern Pacific. The Isthmus of Panama has, since its establishment in the Pliocene, acted as an extrinsic barrier in the separation of populations and has thereby influenced the consequent pattern of speciation. Allopatric species-pairs, nominal genera and subgenera like *Phyllodina*, *Laciolina* and *Elliptotellina*, are good examples of super-species.

TABLE II. Western Atlantic species and their Eastern Pacific Analogs

<i>Western Atlantic</i>	<i>Eastern Pacific</i>
<i>listeri</i>	<i>cumingii</i>
<i>laevigata</i>	<i>viridotincta</i>
<i>squamifera</i>	<i>pristiphora</i>
<i>persica</i>	<i>fluctigera</i>
<i>americana</i>	<i>pacifica</i>
<i>cristallina</i>	<i>rhynchoseuta</i>
<i>aequistriata</i>	<i>reclusa</i>
<i>martinicensis</i>	<i>proclivis</i>
<i>juttingae</i>	<i>lyra</i>
<i>angulosa</i>	<i>eburnea</i>
<i>alternata</i>	<i>laceridens</i>
<i>punicea</i>	<i>simulans</i>
<i>nitens</i>	<i>inaequistriata</i>
<i>mera</i>	<i>meropsis</i>
<i>tampaensis</i>	<i>suffusa</i>
<i>exerythra</i>	<i>erythronotus</i>
<i>sybaritica</i>	<i>amianta</i>
<i>gibber</i>	<i>hiberna</i>
<i>iris</i>	<i>virgo</i>
<i>sandix</i>	<i>esmeralda</i>
<i>pseudocarnaria</i>	<i>chroma</i>
<i>pisiformis</i>	<i>panamensis</i>
<i>mirabilis</i>	<i>lenticula</i>
<i>gabbi</i>	<i>disjuncta</i>
<i>producta</i>	<i>ervilia</i>
<i>cristata</i>	<i>burnetti</i>

In Table III, a similar pattern within polytypic groups of the Western Atlantic is evident. Twelve species-pairs, representing nearly 50% of the total number of species are allopatrically distributed. Extrinsic mechanisms of isolation are not as obvious as the definitive features of the Isthmus of Panama but include the limitations of gene flow between allopatric populations imposed by shorter larval periods, adverse current conditions, or larval substrate specificities.

In summation, the pattern of distribution in the Tellininae is consistent with that exhibited by other littoral marine groups, namely that boundaries established by temperature, current, and other hydrographic conditions do delimit geographical ranges at such points as Cape Hatteras, the Straits of Florida, and southern Brasil. In addition, the pattern of distribution within and between species-groups is largely allopatric, that

is to say that the nearest relatives of a species are isolated geographically from each other. Such a fact is consonant with, as well as supportive of, the accepted thesis of geographic speciation.

TABLE III. Allopatric species-pairs in the Western Atlantic

sandix	iris
gibber	versicolor
tenella	sybaritica
diantha	probrina
euvitrea	probrina
agilis	texana
juttingae	martinicensis
alerta	aequistriata
angulosa	alternata
alternata	tayloriana
radiata	brasiliiana
squamifera	persica

SYSTEMATIC TREATMENT

Family Tellinidae

Gills small, posterior, not plicate, the outer demibranch dorsally directed and a reflected lamina obsolete or lacking; labial palps very large, more or less united posteriorly. Byssal apparatus obsolete. Foot compressed, short and not grooved. Mantle margins papillose with a large ventral pedal gap. Siphons long, extensile, separate to their bases and capable of retraction into an extensive pallial sinus. Ligament external, opisthodetic and generally subtended by nymphal callosities. Hinge with two cardinal teeth in each valve; lateral dentition present or absent. Cruciform muscles posterior.

Subfamily Tellininae

Shell narrowly or broadly lanceolate to ovate in shape, the posterior side generally shorter and often strongly flexed to the right posteriorly. Valves usually of unequal convexity, the left larger and more convex. Hinge with both cardinal and lateral teeth. Surface sculptured concentrically, sculpture generally heavier on the rostral areas.

KEY TO GENERA AND SUBGENERA OF TELLININAE IN THE WESTERN ATLANTIC

1. External sculpture of shell with flexuous scissulations *Strigilla*
External sculpture of shell without flexuose scissulations 2
2. Both anterior and posterior dorsal margins spinose *Tellidora*
Both anterior and posterior dorsal margins not spinose 3
3. Posterior dorsal slope with strong radial sculpture *Elliptotellina*
Posterior dorsal slope with concentric sculpture 4
4. Surface of disc obliquely grooved with scissulations *Scissula*
Surface of disc not obliquely grooved with scissulations 5
5. Right anterior lateral tooth proximal or subproximal to the cardinal complex . . 6
Right anterior lateral tooth distal to the cardinal complex 9

6. Calcareous element of the ligament greatly thickened and sunken . . . *Laciolina*
Calcareous element of the ligament, if thickened, not sunken 7
7. Pallial sinus obliquely ascending *Arcopagia*
Pallial sinus not obliquely ascending 8
8. Right posterior lateral tooth strong; supportive rib internally . . . *Eurytellina*
Right posterior lateral tooth weak; internal rib lacking *Angulus*
9. Shell smooth and polished externally 10
Shell not smooth, with strong concentric sculpture 11
10. Pallial sinus confluent with the pallial line at the base of the anterior
adductor muscle scar *Acorylus*
Pallial sinus confluent with the pallial line posterior to the base of the
anterior adductor muscle scar *Tellina*, s.s.
11. Pallial sinus not connected to the anterior adductor muscle scar by a
linear scar *Merisca*
Pallial sinus connected to the anterior adductor muscle scar by a linear scar . 12
12. Shell strongly flexed to the right posteriorly *Tellinella*
Shell not strongly flexed to the right posteriorly *Phyllodina*

Genus *Tellina* Linnaeus

Tellina Linnaeus 1758, Systema Naturae, Ed. 10, p. 674 (type species, *Tellina radiata* Linnaeus 1758, subsequent designation Schmidt 1818, p. 51).

Description. Shell small to large, elliptical to ovate in shape, left valve generally more convex than the right, variously flexed to the right posteriorly. Fragile to solid. Concentric sculpture predominant. Hinge with cardinal and lateral dentition. Cardinal teeth two in each valve: in the left valve, the anterior cardinal tooth is bifid and the posterior cardinal tooth is single and laminate; in the right valve, the anterior cardinal tooth is single and laminate and the posterior cardinal tooth is bifid. Lateral dentition variously developed, but lateral teeth of the right valve strong. Pallial sinus variously formed. Shell white to highly colored.

Considerable controversy has reigned over the question of the designation of the type species for the genus *Tellina*. Most early designations, including those of Children (1823, p. 305), Gray (1847, p. 186), and Stoliczka (1870, p. 116), cite *Tellina radiata* Linnaeus as type. In 1900, Dall employed *Tellina virgata* Linnaeus as the type species which was used with reference to Lamarck (1799). Thiele (1935) followed Dall in this usage and recently Olsson (1961) has adopted this designation.

This confusion has arisen in regard to the question of the validity of type species designations by Lamarck. Dodge (1947), quoting a statement from Lamarck's introduction to the Prodrôme, has argued that the examples cited by Lamarck represent type designations. In Opinion 79 of the International Rules of Zoological Nomenclature, the examples cited by Lamarck in his Systeme of 1801 are rejected as bonafide type designations (Kennard, Salisbury, and Woodward, 1931). It is possible that this opinion may be extrapolated to the Prodrôme of 1799. In the new Code of Zoological Nomenclature (1961), Article 69 (a) (iii) states:

“In the absence of a prior valid type-designation for a nominal genus, an author is considered to have designated one of the originally included nominal species, if he states that it is the type (or type-species), for whatever reason, right or wrong, and if it is clear that he himself accepts it as a type-species.”

Certainly Lamarck did not select a type in the rigidly construed sense since it can be seen that he changed the example under the genus *Tellina* in the 1801 work to *Tellina radiata* Linnaeus. The first type designation of *Tellina* is that of Schmidt (1818) and not that of Children (1823) as some workers have cited. Schmidt tabulated the work of Gmelin, Bruguière, Lamarck, von Mühlfeld and Oken. In the case of Lamarck, he referred to the *Système* of 1801 and thereby cited *Tellina radiata* as type; the genus then is defined as *Tellina* Linnaeus, *sensu* Lamarck 1801.

Subgenus *Tellina* s.s.

Tellina Linnaeus. Lamarck 1801, *Système Animaux*, p. 124 (type species, *Tellina radiata* Linnaeus 1758, subsequent designation Schmidt 1818, p. 51).

Tellinarius Dumeril 1806, *Anat. Zool.*, Index.¹

Musculus Mörch 1853, *Catalogus Conchyliorum Comes di Yoldi*, 2: 13 (type species, *Tellina radiata* Linnaeus 1758, monotypy), *non* Röding 1798.

Liotellina Fischer 1887, *Manuel Conchyliologie*, p. 1147 (type species, *Tellina radiata* Linnaeus 1758, original designation).

Description. Shell of medium to large size, elongate-subelliptical in shape, moderately thick and flexed to the right posteriorly. Sculpture smooth, consisting of fine radial or concentric lines. Lateral dentition strong in the right valve and consisting of a distal anterior and a distal posterior tooth. Laterals of the left valve more or less poorly developed and equidistant from the cardinal complex. Pallial sinus large, extending near to the anterior adductor muscle scar and descending arcuately to the pallial line. The pallial sinus is posteriorly confluent with the pallial line for about half the ventral length.

The problems in the selection of a type species for the genus have been discussed under the generic heading. Schmidt's designation has the effect, as pointed out by Salisbury (1934) of reducing *Tellina* s.s. to a relatively small group or species. The subgenus appears to have attained its highest development in the Western Atlantic. The peculiarly twisted *Tellina chariessa* Salisbury (= *elegans* Gray) represents the group in the Indo-Pacific, and *Tellina* s.s. is conspicuously absent from the Eastern Pacific.

KEY TO THE SPECIES OF *TELLINA* s.s. IN THE WESTERN ATLANTIC

1. Shell large, exceeding 45 mm. in adult length; some red coloration . . . 2
Shell small, less than 45 mm. in adult length; no red coloration . . . 3
2. Internally, shell white with rays or suffusions of yellow orange or red . . . *radiata*
Internally, deep red purple . . . *brasiliانا*
3. Periostracum golden-brown; shell solid . . . *iheringi*
Periostracum olivaceous green; shell thin . . . *petitiana*

¹ As Dall, Bartsch and Rehder (1938) point out *Tellinarius* Dumeril was used as an exact definition of *Tellina* Linnaeus and therefore becomes an absolute synonym for *Tellina* s.s.

***Tellina (Tellina) radiata* Linnaeus**

Plate 129; figs. 1-4; Plate 130, fig. 1

Tellina radiata Linnaeus 1758, Systema Naturae, Ed. 10, p. 675 (In Oceano Europaeo) [type locality, here corrected and restricted, Montego Bay, Jamaica; type specimens, in collection of Linnean Society, London].

Tellina unimaculata Lamarck 1818, Animaux s. Vertebres, 5: 521 (l'Océan d'Amerique) [type locality, here restricted, Montego Bay, Jamaica; syntypes, Museum d'Histoire Naturelle, Geneva].

Tellina (Musculus) radiata Linnaeus. Mörch 1853, Catalogus Conchyliorum Comes di Yoldi, 2: 13.

Tellina (Tellina) radiata Linnaeus. H. and A. Adams 1856, Genera Recent Mollusca, 2: 394.

Tellina (Eutellina; Liotellina) radiata Linnaeus. Fischer 1887, Manuel Conchyliologie, p. 1147.

Description. Shell extending to 114 mm. (about $4\frac{1}{2}$ inches) in length and to 53 mm. (about $2\frac{1}{4}$ inches) in height, elongate-elliptical, solid, moderately tumid, with the left valve more convex and with a weak flexure to the right posteriorly. Umbos subcentral and slightly inflated. Anterior margin smoothly rounded; ventral margin straight and with a marked postbasal constriction; posterior dorsal margin gently sloping and long; posterior margin short and forming a sloping truncation. Sculpture consisting of evenly spaced obsolete concentric lines; fine radial lirations intersect the concentric lines and produce a microscopic cancellate pattern. Ligament dark brown and protuberant. Calcareous element of the ligament subtended by nymphal callosities. In the left valve, the cardinal complex consists of an anterior strong bifid tooth whose anterior lobe is larger and of a posterior thin laminate tooth; the lateral teeth are both distal to the cardinal complex and weak or obsolete. In the right valve, the cardinal complex consists of a posterior strong bifid tooth with equal lobes and of an anterior strong but thin laminate tooth; the lateral teeth are both distal to the cardinal complex, but extremely well developed and strong. An internal strong supportive ridge radiates from the umbonal region toward the anterior adductor muscle scar. Adductor muscle scars well impressed. Pallial sinus nearly contiguous with the anterior adductor scar, more or less linguiform, not rising above the adductor scars and confluent with the pallial line for about one half its ventral length. Externally the color of the shell varies from pure white to alternating

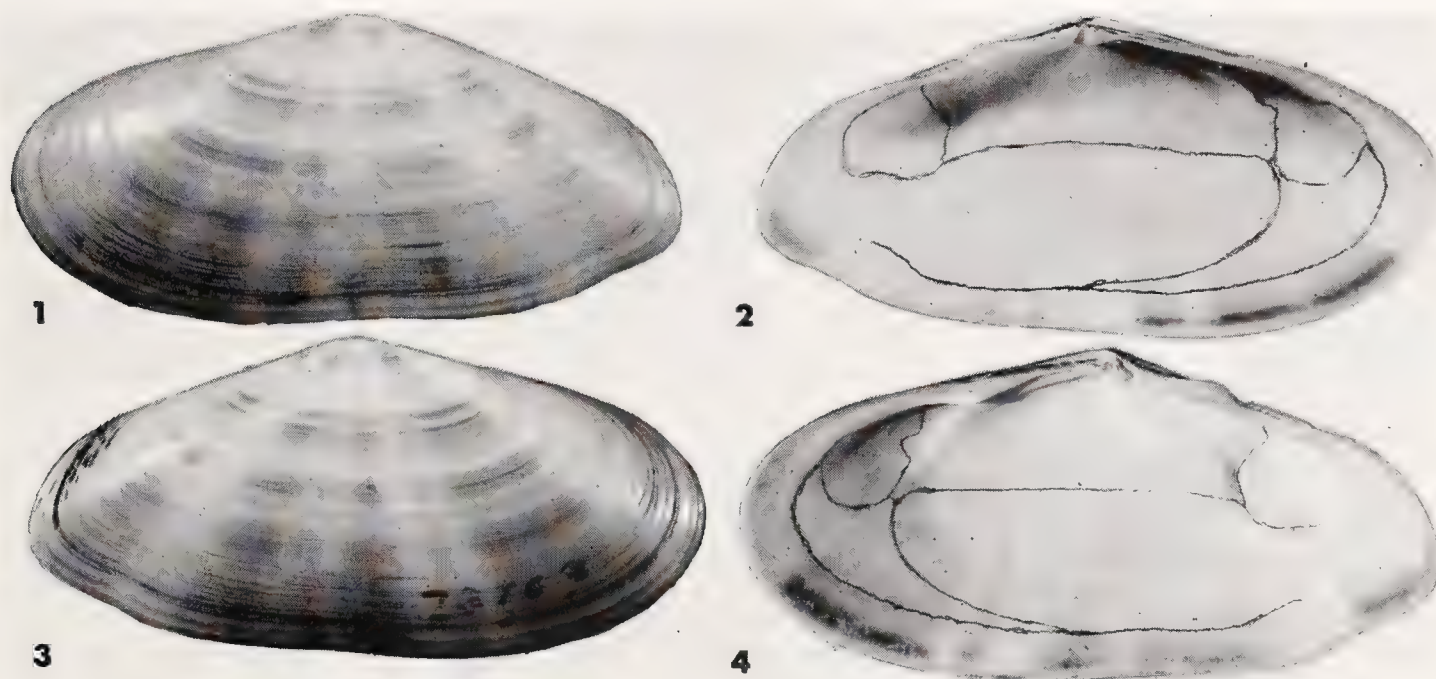


Plate 129. *Tellina radiata* Linnaeus. Fig. 1. External view of the left valve. Fig. 2. Internal view of the left valve. Fig. 3. External view of the right valve. Fig. 4. Internal view of the right valve. Great Abaco Island, Bahamas, USNM 73109 (about 1x) [L=70.2 mm.]. L=length

rays of red and pink which broaden peripherally. Internally, the shell may be suffused with pale yellow or red.

length	height	width	
88.0 mm.	41.0 mm	24.0 mm.	Syntype of <i>radiata</i> Linnaeus
86.0	42.0	20.0	Syntype of <i>unimaculata</i> Lamarck
114.0	53.0	28.5	Cat Island, Bahamas
64.0	32.0	16.5	Tortola, Virgin Islands
19.0	9.0	4.2	Great Inagua, Bahamas

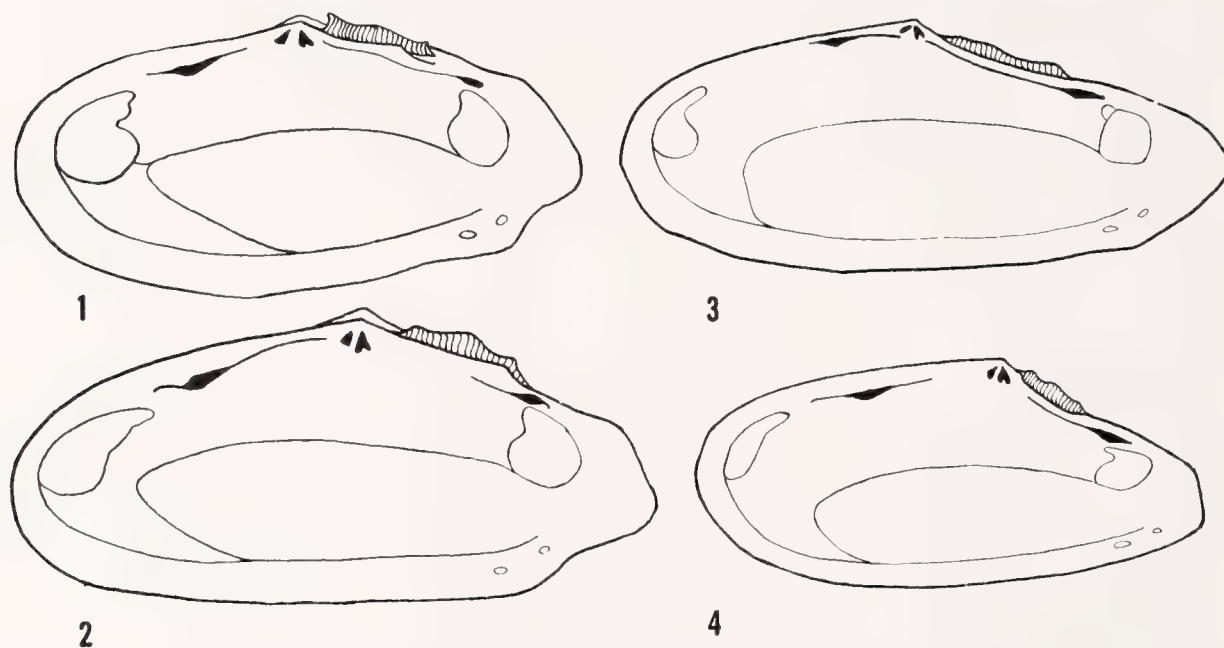


Plate 130. Figs. 1-4. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina radiata* Linnaeus (about 1.2x) [L=50 mm.]. Fig. 2. *Tellina brasiliiana* Spengler (about 1.4x) [L=50 mm.]. Fig. 3. *Tellina petitiana* d'Orbigny (about 2x) [L=33 mm.]. Fig. 4. *Tellina iheringi* Dall (about 1.7x) [L=30 mm.].

Remarks. This species may be considered one of the more successful species of *Tellina* in the Western Atlantic. Of a subtropical to tropical range, it seems to have a central, most concentrated population in the Bahamas.

In a series of individuals from the same locality, a continuum in the stages of growth and development may be observed. An allometric pattern is definitely evident when smaller and younger individuals are contrasted with larger and older ones. In the smaller individuals, the anterior dorsal margin is more elongate, more smoothly and gently sloping than in adults; this margin occupies a larger percentage of the total length as well. The nymphal callosity and the calcareous layer of the ligament are most often equal in length, but the total length of each of these structures varies in individuals according to age. In general, older individuals which possess heavier and larger shells also have a longer nymph. The posterior indented arcuation of the ventral margin also increases in strength with age.

The characters which are most variable are the color and the color pattern of the shell. Lamarck (1818) named the white rayless form, *unimaculata*. White individuals of *radiata* reflect the polymorphic nature of the species and are found in nearly all populations regardless of geographical distribution. Some kind of radial pattern of red seems to be the general configuration of external coloration. The same generalization is true of the pattern and coloration on the internal surface of the valves, but in addition, yellow coloration seems to be stronger and more intensely concentrated in the central disc area of the

internal surface. More often than not, there is a concentration of red on the umbonal region of the shell even in those individuals that are predominantly white.

This species is an inhabitant of the shallow slope waters, and Robertson (59) has indicated that it is a typical representative of the offshore sand community. Abbott (1958) described its habitat preferences in Grand Cayman; in this locality, *radiata* occurred in clear sand at depths between 6 and 48 feet; it seemed to prefer fairly clear ocean water and was not found in the warm inshore shallows.

The fossil record of this species is incomplete; it is known to occur in the Pleistocene (Rehder, 1962). The closest relative of *T. radiata* in the Western Atlantic is *T. brasili-ana* Spengler. In the Indo-Pacific, *Tellina chariessa* Salisbury is similar to *radiata*, but the former is asymmetrically twisted.

Range. *Tellina radiata* occurs from Lake Worth, Florida south through the Greater and Lesser Antilles to the Guianas in South America.

Specimens examined. FLORIDA: Lake Worth; Pompano (both MCZ); Fort Lauderdale (ANSP); Miami (USNM); Key Biscayne; Virginia Key; Hawks Channel, Garden Cove, Key Largo, in 2 fathoms (all MCZ); Conch Key, in 1–5 feet (USNM); Grassy Key (ANSP); Key Vaca; Bahia Honda Key (both MCZ); Key West; Loggerhead Key, Tortugas (both USNM); Sanibel (USNM; CNM); Boca Grande, Gasparilla Island (ANSP); Paradise Beach, Hog Island (ANSP); Cedar Keys (USNM; MCZ). MEXICO: 15 miles N of Tecolutla, Veracruz (MCZ); Campeche (ANSP); Progreso; Cabo Catoche (both MCZ); Cozumel Island (ANSP). BRITISH HONDURAS: Belize (MCZ); St. Georges Cay (USNM). HONDURAS: Utila Island (USNM). BERMUDA: Castle Roads, Castle Harbour, in 4–5 fathoms (MCZ); off Nonesuch, in 15 feet (USNM); Long Beach, Warwick (MCZ). BAHAMAS: Cay Sal; Alicetown, North Bimini (both MCZ); Nixon's Harbour, South Bimini; Gun Cay (both ANSP); Dollar Harbour, South Cat Cay; West End, Wood Cay, Eight Mile Rock, Hawksville Creek, Holmes Cay, Sweetings Cay, and Freetown, Grand Bahama; Green Turtle Key, Tilloo Cut, and Marsh Harbour, Great Abaco (all MCZ); Mintie Bar, Andros (USNM); North Cay, Nassau Harbour, Dick's Point, Fox Hill, Culbert Point, North Cay, Adelaide, Old Fort and Lake Cunningham, New Providence; Governor's Harbour and Sandy Point, Eleuthera; Arthurstown, North End Point, Russell Creek, Orange Creek, Campdown and Landing Rock, Cat Island; Little San Salvador Island; Stocking Island, Great Exuma; Watlings Island; Cockburntown, San Salvador; Simms, Cape St. Marie, and Clarence Town, Long Island (all MCZ); Lobos Island; Rocky Point, Crooked Island (both USNM); Fortune Island; Atwood's Cay; Abraham's Bay, Mariguana Island; Turks Island; Matthew Town, Great Inagua (all MCZ). CUBA: Cape San Antonio; Cape Cajon; Cayo Levisa (all USNM); Habana; Pueblo Nuevo, Matanzas (both MCZ); Cayo Galindo, Cardenas (CNM); Cayo Cristo, Sagua la Grande, La Sortija, Cayo Caiman and Cayo Frances, Las Villas; Cayo Maja Figuro, Camagüey; Punta de los Colorados, Cienfuegos Bay (all MCZ); 20 miles W of Santiago (USNM). JAMAICA: Montego Bay (USNM); Portland Point; Middle Cay, Pedro Bank (both MCZ). HISPANIOLA. HAITI: Baie des Flamands; Les Sept Freres Islands (both USNM). SANTO DOMINGO: Monte Cristi; Puerto Plata (both MCZ). VIRGIN ISLANDS: Anegada Island (ANSP); Devil's Bay, Virgin Gorda; Tortola; Guana Island; Cancel Bay, St.

John; Bird Key, St. Thomas; Sandy Point, St. Croix (all MCZ). LESSER ANTILLES: St. Martins (ANSP); St. Kitts (MCZ); Nevis (ANSP); Falmouth Harbour, Antigua, in 3–6 fathoms (USNM); Guadeloupe; Barbados (both ANSP). CARIBBEAN ISLANDS: Georgetown, Low Point, West Bay and Little Bluff, Grand Cayman (all ANSP). Swan Island; Curaçao (both MCZ). VENEZUELA: La Guayra; Orchilla Island (both USNM). BRITISH GUIANA: SE coast of British Guiana (ANSP).

***Tellina (Tellina) brasiliana* Spengler**

Plate 130, fig. 2; Plate 131, fig. 1

Tellina brasiliana Spengler 1798, *Skrivter Naturhistorie Selskabet*, 4(2): 94, pl. 12, fig. 4 (Fra Brasilien), non Lamarck 1818 [type locality, here restricted, Praia de Itapoan, Bahia, Brasil; holotype, Zoological Museum, Copenhagen].

Tellina semizonalis Lamarck 1818, *Animaux s. Vertebres*, 5: 521 (no locality given); Delessert, 1841, pl. 6, fig. 1 [type locality, here restricted, Praia de Itapoan, Bahia, Brasil; holotype, Museum d'Histoire Naturelle, Geneva].

Tellina (Tellina) brasiliana Spengler. H. and A. Adams 1856, *Genera Recent Mollusca*, 2: 394.

Tellina (Musculus) brasiliana Spengler. Römer 1870, *Conchilien-Cabinet* (2), 10(4): 9, pl. 5, figs. 1–3.

Description. Shell extending to 103 mm. (about 4 inches) in length and to 50.5 mm. (about 2 inches) in height, elongate-lanceolate, solid, with the left valve more convex and with a strong flexure to the right posteriorly. Umbos slightly posterior to the middle and pointed. Anterior margin very narrowly rounded; ventral margin straight and with a slight indented arcuation behind; anterior dorsal margin rather long and straight; posterior dorsal margin gently descending and straight; posterior margin slightly convex and forming a short oblique posterior truncation. Sculpture consisting of weak, evenly spaced concentric lines; radial lirae present. Ligament dark brown and protuberant. Calcareous element subtended by a thickened nymphal callosity. In the left valve, the cardinal complex consists of an interior thickened, strong bifid tooth whose anterior lobe is larger and of a posterior thin laminate tooth; the lateral teeth are both distal to the cardinal complex and quite weak or obsolete. In the right valve, the cardinal complex consists of a posterior strong bifid with subequal lobes and of an anterior strong but thin laminate tooth; the lateral teeth are both distal to the cardinal complex but extremely well developed and strong. Adductor muscle scars moderately well impressed; pallial sinus rises slightly behind, is slightly convex above and falls to the pallial line in a position beneath the umbos. The sinus extends to, but does not coalesce with the anterior adductor muscle scar. Externally the shell is polished and white with a purplish tinge and may appear banded with red and purple; internally the shell is polished and purple with a white periphery.

length	height	width	
103.0 mm.	50.5 mm.	33.0 mm.	Holotype of <i>brasiliana</i> Spengler
45.0	21.0	9.0	Holotype of <i>semizonalis</i> Lamarck
78.0	39.0	—	Brasil
52.0	22.0	—	Praia de Itapoan, Brasil

Remarks. The status of this species has been somewhat controversial, due in part to its rare occurrence. The nearest relative of *Tellina brasiliana* is the very common West Indian species, *T. radiata*. The distributions of the present species are allopatric and indicative of a geographical separation of the ancestral populations. The most spectacular

difference between *brasiliانا* and *radiata* is the color of the shell. *Tellina brasiliانا* possesses a purple interior and a variously rayed and banded exterior whereas *radiata* varies between a pure white shell and one which is rayed externally and internally with red, yellow or orange. Furthermore, the posterior flexure to the right, the radial lirae, the curvature of the right valve and the posterior internal ribs and rays are all stronger in *brasiliانا*. Other important and diagnostic traits include the closely set, strongly incised, and parallel sculpture along the posterior slope in *brasiliانا*.

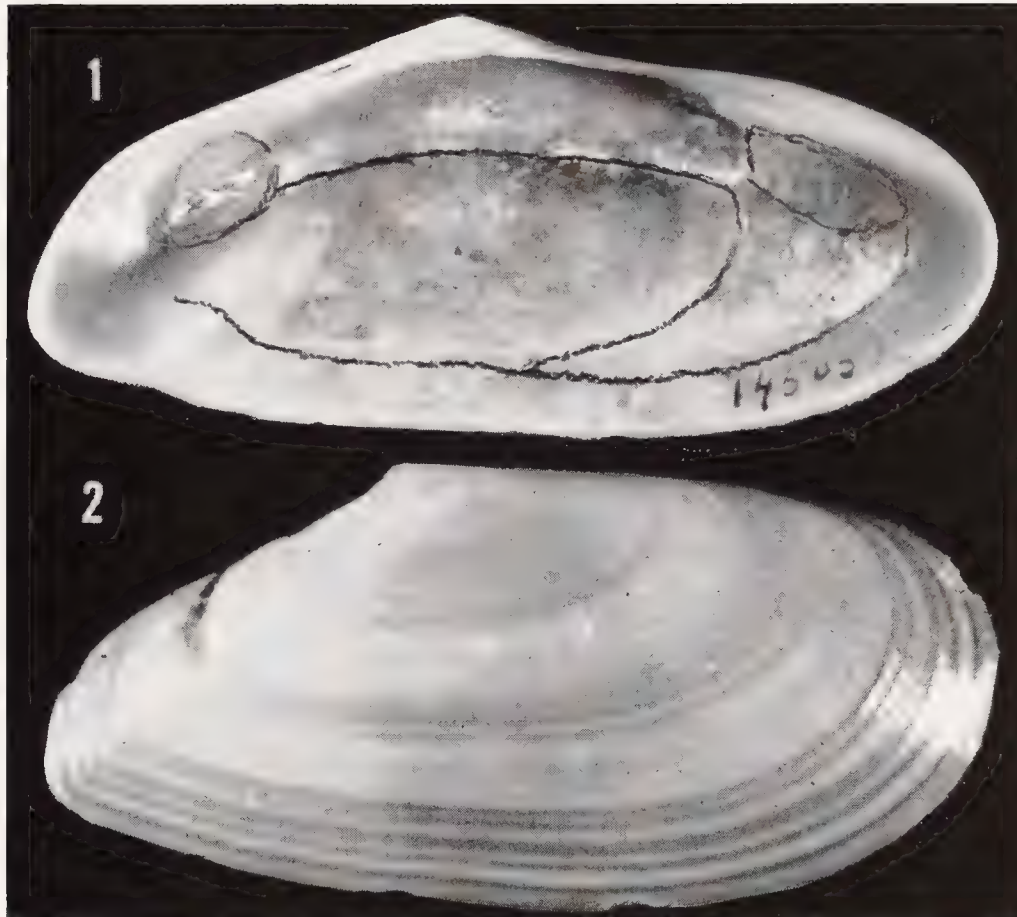


Plate 131. Fig. 1. *Tellina brasiliانا* Spengler. Internal view of the left valve, Praia de Itapoan, Brasil, MCZ 145057 (about 2.2x) [L=52 mm.]. Fig. 2. *Tellina iheringi* Dall, external view of the right valve, Golfo San Matias, Argentina, MCZ 145058 (about 3x) [L=31.5 mm.].

Range. The distribution of this species seems to be wholly confined to the coast line of Brasil. Oliveira in an unpublished manuscript has given the single locality of Ceará (Fortaleza) for this species. The only other known specific locality is the Praia de Itapoan at Bahia.

Specimens examined. BRASIL: (BMNH; ZMK); Praia de Itapoan, Estado do Bahia (MCZ).

***Tellina (Tellina) iheringi* Dall**

Plate 130, fig. 4; Plate 131, fig. 2

Tellina (Liotellina) iheringi Dall 1900, Proc. U.S. Nat. Mus., 23: 311, fig. 2 (type locality, *Albatross I* station 2765, off Rio de la Plata, in 10½ fathoms [18 miles NE of Punta Mendanos, 36°43' S; 56°23' W]; holotype, USNM, no. 108531).

Description. Shell extending to 35.5 mm. (about 1¼ inches) in length and to 17.5 mm. (about ⅝ inches) in height, elongate, subsolid, with the right valve only slightly more

convex and with a weak posterior flexure to the right. Umbos posterior to the middle and blunt. Anterior margin narrowly rounded; ventral margin convex and gently rising posteriorly; anterior dorsal margin long and gently sloping; posterior dorsal margin gently sloping and slightly concave; posterior margin short and forming an ill-defined truncation. Concentric sculpture absent or consisting of weak lirations which are strongest on the posterior slope; radial vermiculations which broaden peripherally occur on the disc. Ligament short and deeply set. Calcareous element subtended by an elevated nymphal callosity. In the left valve, the cardinal complex consists of an anterior strong deltoid bifid tooth with subequal lobes and of a posterior weak, very long and thin laminate tooth; anterior lateral tooth distal and very weak; posterior lateral tooth distal, poorly developed, but stronger than the anterior lateral tooth. In the right valve, the cardinal complex consists of a posterior strong bifid tooth with subequal lobes and of an anterior thickened laminate tooth; the anterior lateral tooth distal, elongate and strong; the posterior lateral tooth distal and smaller than the anterior lateral; both lateral teeth socketed. Adductor muscle scars rather poorly impressed. Anterior adductor scar elongate, narrow and rounded below; posterior adductor rounded. Pallial sinus equal in both valves, slightly convex above and falling in a sharp arcuation to the pallial line. The pallial sinus is widely separated from the anterior adductor scar. The shell is polished and white, covered externally by a yellowish brown periostracum, which shows darker concentric bands. Internal surface white, polished and shining.

length	height	width	
27.0 mm.	13.0 mm.	5.5 mm.	Holotype of <i>iheringi</i> Dall
35.5	17.5	8.0	Punta Norte, Golfo San Matias
31.5	14.0	6.5	Punta Bermeja, Golfo San Matias
24.4	11.3	4.2	Montevideo, Uruguay

Remarks. *Tellina iheringi* is allied to *Tellina petitiana* and both of these species are more or less restricted to the continental slope fauna of southeastern South America. The close relationship of these species is expressed in a similarity of general characteristics. *Tellina iheringi* is more tumid or inflated than *T. petitiana*. There is a difference in the basic proportions of the shells and this is most easily discerned in the nature of the posterior dorsal slope. In *petitiana*, this margin drops off very sharply from the umbonal area whereas in *iheringi* there is only a gentle inclination with little indication of concavity. The valve thickness of *iheringi* is greater and the periostracum is of a yellowish brown coloration in contrast to the gray-green color exhibited by *petitiana*.

Range. This species is more or less restricted to the coast of Argentina at depths between 7 and 30 fathoms in sandy substrate; its northernmost record is off Montevideo, Uruguay and its southernmost, off Punta Bermeja, Argentina.

Specimens examined. URUGUAY: *Hassler* station, 8 miles SE of Montevideo (31°12' S; 55°30' W) in 7 fathoms (MCZ). ARGENTINA: *Albatross I* station 2764, 19 miles NE of Punta Mendanos (36°42' S; 56°23' W), in 11.5 fathoms; *Albatross I* station 2765, 18 miles NE of Punta Mendanos (36°43' S; 56°23' W), in 10.5 fathoms (both USNM); *Hassler* station, 17 miles NNE of Punta Rasa (40°22' S; 60°35' W), in 30 fathoms; *Hassler* station, off Bahia Rosas, Golfo San Matias (41°15' S; 63°50' W), in 25 fathoms;

Hassler station, off Punta Bermeja, Golfo San Matias ($41^{\circ}17' S$; $63^{\circ}00' W$), in 17 fathoms (all MCZ).

***Tellina (Tellina) petitiana* d'Orbigny**

Plate 130, fig. 3; Plate 132

Tellina petitiana d'Orbigny 1846, Voyage Amer. Cent., p. 537, n. 540, pl. 81, figs. 26-27 (au large du cap Saint-Thomé, sur la côte du Brésil) [holotype, BMNH, no. 54.12.4.696].

Tellina petitiana d'Orbigny. Smith 1915, Terra Nova Reports, Mollusca, Pt. 1, p. 101.

Description. Shell extending to 45 mm. (about $1\frac{3}{4}$ inches) in length and to 23 mm. (about 1 inch in height, elongate, lanceolate posteriorly, thin, fragile, compressed, with the right valve slightly more convex than the left and with a weak posterior flexure to the right. Umbos central and pointed. Anterior margin broadly rounded; ventral mar-

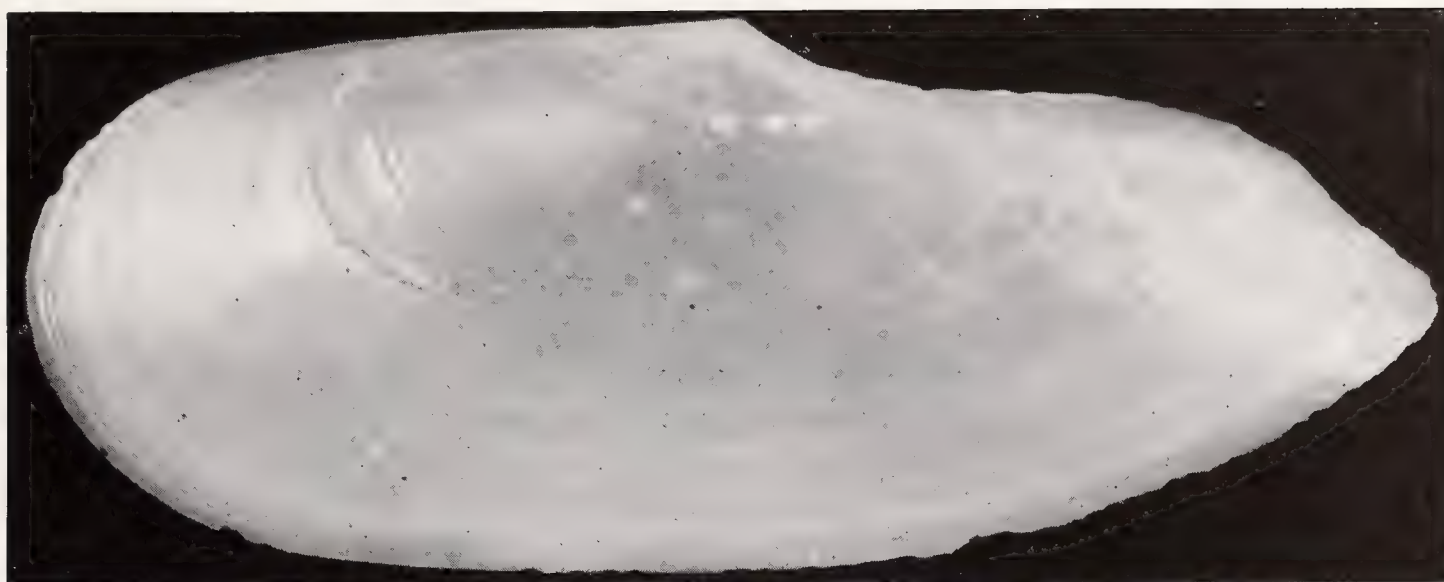


Plate 132. *Tellina petitiana* d'Orbigny, external view of the left valve of the holotype, São Tomé, Brasil, BMNH (about 3.8x) [L=38 mm.].

gin straight and rising in a postbasal arcuation; anterior dorsal margin long and slightly convex; posterior dorsal margin long and gently sloping. Sculpture consisting of closely set, weak concentric lirations; radial sculpture consisting of extremely fine vermiculations on the disc which broaden peripherally. Posterior ridge and sulcus present. Ligament dark brown and not protuberant. Calcareous element of the ligament not strongly developed and subtended by very weak nymphal callosities. In the left valve, the cardinal complex consists of an anterior deltoid bifid tooth with subequal lobes and of a posterior elongate, laminate tooth; anterior and posterior lateral teeth absent or obsolete, consisting of distal thickening of the hinge plate. In the right valve, the cardinal complex consists of a posterior subdeltoid bifid tooth whose anterior lobe is larger and of an anterior, divergent thickened laminate tooth; anterior lateral tooth subproximal, long, thin and rather fragile; the posterior lateral tooth distal and elongate; both laterals socketed. Adductor muscle scars moderately well impressed. The anterior adductor somewhat elongate but rounded below; the posterior adductor irregularly rounded. Pallial sinus equal in both valves, rising only slightly above the base of the posterior adductor, irregularly flattened above and descending in a smooth broad arcuation to the pallial line. The pallial sinus is widely removed from the anterior adductor scar. Shell

predominantly white, covered by a thin olivaceous periostracum which often adheres peripherally; rarely iridescent. Internally, white, shining, but not polished.

length	height	width	
38.0 mm.	14.8 mm.	2.3 mm.	Holotype of <i>petitiana</i> d'Orb.
45.0	23.0	7.0	San Antonio, Argentina
28.5	11.5	3.5	La Paloma Rocha, Uruguay
12.0	6.0	—	off Montevideo, Uruguay

Remarks. *Tellina petitiana* appears to be most closely related to *Tellina iheringi*; both species inhabit a similar area off the coast of southern South America. From *iheringi*, *petitiana* may be distinguished by its thinner and more fragile shell, its lateral compression and its predominantly gray-green periostracum. The posterior dorsal slope in *petitiana* falls sharply from the umbonal region and is more convex and longer than the same margin in *iheringi*. In addition, the posterior slope of *petitiana* is demarcated by a superficial ridge or a number of ridges.

It may appear that the relationship of this species with other members of the subgenus *Tellina* is somewhat distant, because the shell lacks the bright coloration and thickness so typical of *Tellina radiata*; however, the smoothness of the sculpture, the configuration of the pallial sinus and the position of the right lateral dentition serve to justify its subgeneric placement.

Range. The northernmost record is the type locality at Cape São Tomé, in Estado do Rio de Janeiro, Brasil; the species ranges south from this locality to the Golfo de San Matias in Argentina. Depth records show that this species occurs between seven and forty fathoms.

Specimens examined. BRASIL: São Tomé (BMNH); Rio de Janeiro (E. A. Smith). URUGUAY: La Paloma Rocha (E. Duarte); *Hassler* station, 8 miles SE of Montevideo (31°12' S; 55°30' W), in 7 fathoms (MCZ). ARGENTINA: *Hassler* station, Port San Antonio, Golfo San Matias; *Hassler* station, off Bahia Rosas, Golfo San Matias (41°15' S; 63°50' W), in 25 fathoms (both MCZ).

Subgenus *Tellinella* Mörch

Tellinella Mörch 1853, *Catalogus Conchyliorum Comes di Yoldi*, 2: 13 (type species, *Tellina virgata* Linnaeus 1758, subsequent designation, Stoliczka 1870, p. 116¹).

Telinella Mörch. H. and A. Adams 1856, *Genera Recent Mollusca*, 2: 394, error for *Tellinella*.

Eutellina Fischer 1887, *Manuel de Conchyliologie*, p. 1147 (type species, *Tellina virgata* Linnaeus 1758, original designation).

Tellinarius 'Froriep' Salisbury 1934, *Proc. Mal. Soc. London*, 21: 78 and 90 (type species, *Tellina virgata* Linnaeus 1758, original designation), *non* Dumeril 1806.

Description. Shell medium to large size, ovate, elongate or elliptical in outline, solid to subsolid, generally equivalve and nearly equilateral, more or less flexed to the right posteriorly. Concentric sculpture developed, strong and often squamose posteriorly; radial sculpture rare. Lateral dentition developed in both valves. In the right valve,

¹The type species is not *Tellina antonii* Philippi as indicated by Salisbury (1934), for Mörch did not cite any type species in his use of the name *Tellinella*; the first known designation was made by Stoliczka.

both lateral teeth are distal to the cardinal complex and strongly developed. In the left valve, both lateral teeth are distal to the cardinal complex and moderately developed. Ligament generally strong with subtending nymphaal callosities. Pallial sinus linguiform and removed from the anterior adductor muscle scar; confluences of the pallial sinus and pallial line short and limited to the posterior half of the shell.

The subgenus is particularly well represented in the Indo-Pacific where the type, *Tellina virgata* Linnaeus, appears to be widespread. The subgenus is tropical to subtropical in its distribution with a single representative in the Western Atlantic and two species in the Eastern Pacific. Stoliczka (1870) has documented the occurrence of the group in the Cretaceous of India. The subgenus also appears to be well established in the Eocene of Europe and North America.

***Tellina (Tellinella) listeri* Röding**

Plate 133, figs. 1–3; Plate 134, fig. 1

Tellina listeri Röding 1798, Museum Boltenianum, p. 185 (West Indies) [type locality, here restricted, St. Kitts; types not seen], *non* Hanley 1844.

Tellina interrupta Wood 1815, General Conchology, p. 146, pl. 36, fig. 3 (Indian and American Seas) [type locality, here restricted, St. Kitts; types lost].

Tellina maculosa Lamarck 1818, Animaux s. Vertèbres, 5: 521 (Indian Seas) [type locality, here restricted, St. Kitts; syntypes, Museum d'Histoire Naturelle, Geneva].

Tellina mexicana Petit 1841, Revue Zoologique, Société Cuvier, 4: 183 (coast of Mexico at Veracruz) [syntypes, Museum d'Histoire Naturelle, Paris].

Tellina (Tellinella) listeri Röding. Mörch 1853, Catalogus Conchyliorum Comes di Yoldi, 2: 13.

Tellina antoni 'Philippi' Krebs 1864, The West-Indian Marine Shells, p. 100, *antonii non* Philippi 1844.

Tellina (Tellina) interrupta Wood. Dall 1900, Proc. U.S. Nat. Mus., 23: 293.

Description. Shell extending to 79 mm. (about $2\frac{3}{4}$ inches) in length to about 41 mm. (about $1\frac{1}{2}$ inches) in height, elongate, solid, somewhat inflated with the left valve slightly more convex and with a very sharp posterior flexure to the right. Umbos central and pointed. Anterior margin narrowly rounded; ventral margin broadly arcuate; anterior dorsal margin long and gently sloping; posterior dorsal margin elongate and straight; posterior margin irregular, divided into two short portions which are more or less oblique to the dorso-ventral axis. Sculpture consisting of strong concentric ridges, separated by well incised sulci; the concentric ridges are stronger along the posterior slope. Rarely radial lirations occur and form a cancellate pattern. Two strong posterior ridges extend from the umbo to the posterior margin in the right valve. Ligament dark brown, strong and protuberant. Calcareous portion of the ligament subtended by thickened nymphaal callosities. In the left valve, the cardinal complex consists of an anterior strong bifid tooth with subequal lobes and of a posterior thin laminate tooth; anterior and posterior lateral teeth rather small and equidistant from the cardinal complex. In the right valve, the cardinal complex consists of a posterior strong slightly skewed bifid tooth whose anterior lobe is the larger and of an anterior slightly thickened laminate tooth; the anterior and posterior lateral teeth distal, well developed and socketed above. Adductor muscle scars well impressed. Posterior adductor scar subquadrate; anterior adductor scar subovate. Pallial sinus rising gently posteriorly, broadly convex above, extending toward the anterior adductor muscle scar but well separated from it; the sinus falls obliquely to the pallial line and the confluence is short; a small linear scar often unites the pallial

sinus and the anterior adductor scar. Externally, the shell is white to purplish, rarely suffused with yellow and vermiculated with chevrons of purple or brown. Internally, the shell is shining but not polished, white, rarely purple and often suffused centrally with yellow.

length	height	width	
79 mm.	41 mm.	22 mm.	Cayo Frances, Caibarién, Cuba
66	36	18	Cat Island, Bahama Islands
53	27	13	Lake Worth, Florida
14	6	4	Anegada Island, Virgin Islands

Remarks. Variation in *Tellina listeri* is considerable and accounts for the lengthy synonymy. The proportions of individuals vary greatly. Small, immature or young individuals tend to be more narrowly elongate than adults. There is evidence for allometric differences where young stages are of a lower height-length ratio than adults. The strength of both concentric and radial sculpture is also variable. Individuals with strong

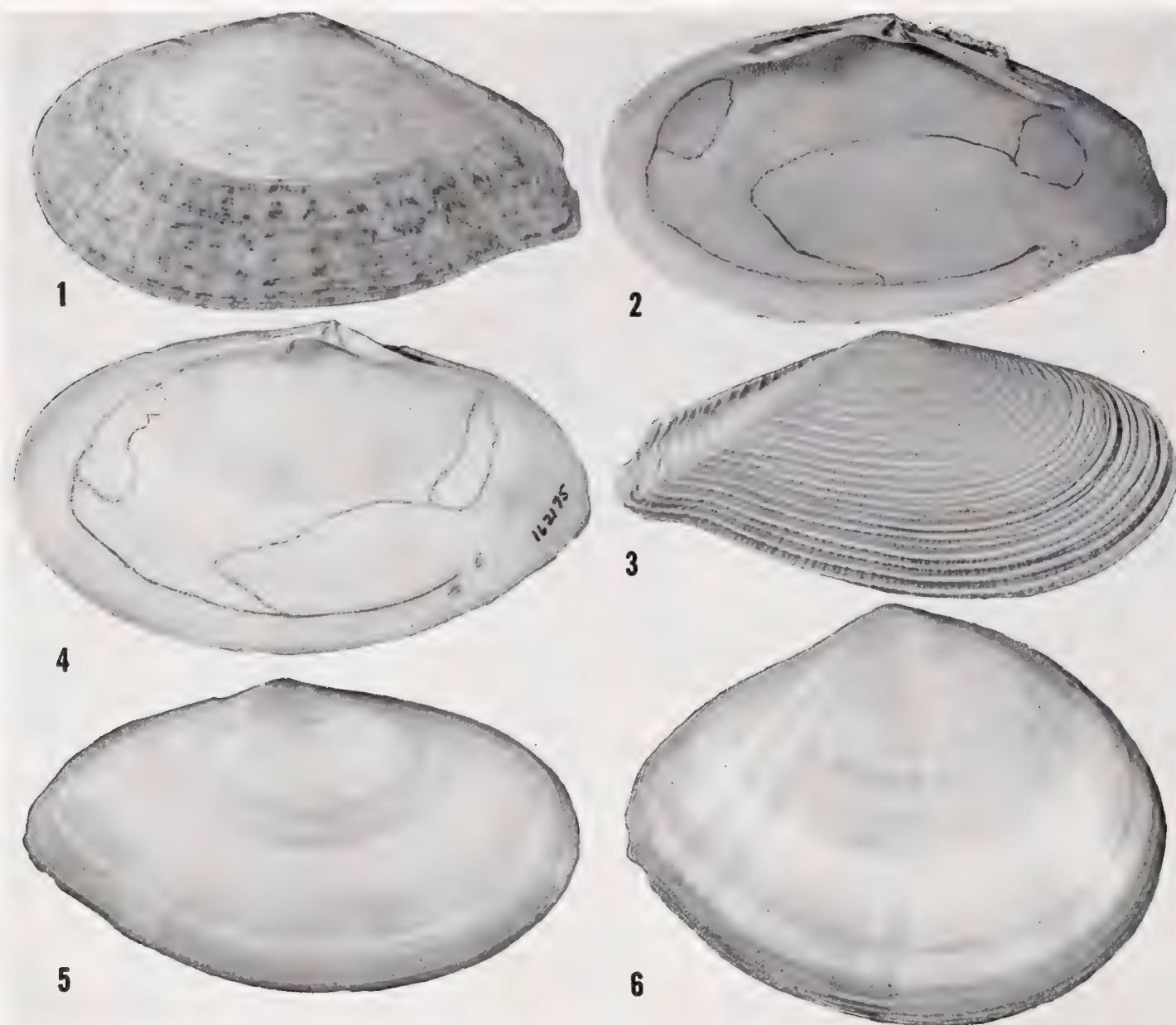


Plate 133. Figs. 1-3. *Tellina listeri* Röding. Fig. 1. External view of the left valve. Fig. 2. Internal view of the right valve, Jamaica, MCZ 155663 (about 1.3x) [L=56 mm.]. Fig. 3. External view of the right valve, Sanibel Island, Florida, MCZ 13503 (about 2x) [L=37 mm.]. Figs. 4-5. *Tellina magna* Spengler. Fig. 4. Internal view of the right valve. Fig. 5. External view of the right valve, Pass-a-grille Beach, Florida (about 0.8x) [L=86 mm.]. Fig. 6. *Tellina laevigata* Linnaeus, external view of the right valve, Abbott's Cliff, Bermuda, MCZ 218421 (about 1.3x) [L=53 mm.].

concentric lamellae may possess only weakly developed radial lirations whereas some specimens have strong sculpture of both the radial and concentric types. Radial sculpture may be developed posteriorly more than it is anteriorly. The color of *listeri* is its most variable characteristic. Pure white individuals are less rare than pure purple specimens. In general, the external surface of the valves is colored with purple or brown. Internally the valves are generally white with a suffusion of yellow; however, individuals with dark purple interiors also occur.

Tellina listeri is very closely related to *Tellina cumingii* Hanley of the Eastern Pacific. The differences between *listeri* and *cumingii* are often matters of degree wherein some individuals of either species remain virtually indistinguishable. In general, populations of *listeri* have more individuals which have higher and larger shells and fewer individuals with serrated or squamous posterior ridges. In *cumingii*, the shell tends to be narrowly elongate and most specimens are rayed with purple. True *Tellina antonii* is a close relative of *T. listeri* and has been reported from St. Helena by Smith (1890), but specimens of this species though very close to *T. listeri*, appear to be predominantly purple in color.

The precursors of *Tellina listeri* first appear in the Eocene of Vicksburg, Alabama. Dall (1900b), Mansfield (1938) and Gardner (1928) have described related forms from the Oligocene and Miocene of Florida. Olsson and Harbison (1953) have recorded the occurrence of the *T. mexicana* from the Pliocene of Florida, and *T. listeri* has been found in Pleistocene strata in Cuba, Grand Cayman Island, and Brasil.

Tellina listeri appears to be characteristic of offshore, coarse sandy substrates. The species lives in depths from one to fifty fathoms and Abbott (1958) found the species limited to sand substrates between six and forty-eight feet in Grand Cayman.

Range. *Tellina listeri* occurs from Cape Lookout, North Carolina and Bermuda through the Bahamas, the Antilles, the Gulf of Mexico and Caribbean Sea to off the coast of Brasil in the vicinity of Bahia.

Specimens examined. NORTH CAROLINA: *Albatross I* station 2607, 18 miles E of Cape Lookout (34°38' N; 76°12' W), in 18 fathoms; *Albatross I* station 2608, 17 miles ESE of Cape Lookout (34°32' N; 76°12' W), in 22 fathoms; *Albatross I* station 2610, 27 miles SE of Cape Lookout (34°20' N; 76°12' W), in 22 fathoms; *Albatross I* station 2616, 25 miles SE of Cape Fear (33°42' N; 71°31' W), in 17 fathoms; *Albatross I* station 2617, 25 miles SE of Cape Fear (33°37' N; 77°36' W), in 14 fathoms; *Albatross I* station 2615, 31 miles ESE of Cape Fear (33°45' N; 77°25' W), in 18 fathoms; *Albatross I* station 2619, 37 miles SE of Cape Fear (33°38' N; 77°36' W), in 15 fathoms; *Fish Hawk* station 7965, 22 miles SSE of New River Inlet (34°14' N; 77°05' W), in 14.5 fathoms (all USNM). GEORGIA: *Pelican* station 178-14, 63 miles E of Altamaha Island (USNM). FLORIDA: *Pelican* station 172-4, 23 miles NE of New Smyrna, in 14 fathoms; *Pelican* station 172-3, 17 miles E of Daytona Beach (both USNM); South Inlet, Lake Worth in 2-3 fathoms; off Palm Beach in 130 fathoms (both MCZ); off Miami in 6-30 fathoms; Hawk Channel, in 3-4 fathoms; off Fowey Light in 6-45 fathoms; off Long Reef in 38 fathoms (all USNM); off Carysfort Reef, Key Largo in 66-117 fathoms (MCZ); Pepper Fish Key in 9 fathoms (USNM); Grassy Key (ANSP); Key Vaca; Sombrero Key; Looe Key; Boca Chica Key (all MCZ); Key West; Tortugas (both USNM); Naples; Sanibel; Boca Grande, Gasparilla Island (all ANSP); off

Longboat Pass (USNM); Egmont Key; Clearwater Harbor; Madeira Beach Treasure Island (all ANSP); off Ancloste Key (USNM); Fort Walton (ANSP); Destin (ANSP; MCZ). MEXICO: Veracruz; Isla del Carmen, Campeche; Isla Mujeres, Yucatan (all MCZ). BRITISH HONDURAS: Belize (MCZ). NICARAGUA: (ANSP). PANAMA: off Panama City (USNM). BERMUDA: Castle Harbor (MCZ); Truck Island, Harrington Sound (USNM); Grace Island (ANSP). BAHAMA ISLANDS: West End, Wood Cay, Hawksbill Creek and Holmes Cay, Grand Bahama Island (all MCZ); Marsh Harbour and Sandy Point, Great Abaco; North and South Bimini Islands; Adelaide, Dick's Point and Foxhill, New Providence; off Mintie Bar, SE of South Bight, Andros; Governor's Harbour and Tarpum Bay, Eleuthera; Arthurstown and Orange Creek, Cat Island; Little San Salvador (all MCZ); Rum Cay (USNM); Clarence Town, Cape St. Maria, and Simms, Long Island (all MCZ); NE Point and Abraham's Bay. Mari-guana (both MCZ); Matthew Town, Alfred Island, and Mangle Bush, Great Inagua (all MCZ); Lobos Island (USNM). CUBA: *Barrera* station 224, Cape San Antonio; *Barrera* station 211, Cape Cajon; *Barrera* station 209, Santa Rosa, in 3–6 fathoms; *Barrera* station 218, Cayo Hutia Reef; *Barrera* station 208, Bahía Honda, in 1–12 fathoms; *Barrera* station 202, Cabanas Harbor, in 25 fathoms (all USNM); La Chorrera, Habana (USNM; MCZ); Veradero Beach, Matanzas (USNM; MCZ); Cayo Cruz, Cayo Bupas, and Comacho Beach, Cardenas (all CNM); Punta de los Colorados, Cienfuegos Bay; Cayo Frances, Caibarién; Leeward Point and Fish Point, Guantánamo (all MCZ). JAMAICA: Montego (USNM); St. Anne's (MCZ); Spanish Point, Pembroke Parish; Great Pedro Bay; Caymanas; Carlisle Bay, in 6 fathoms (all USNM).

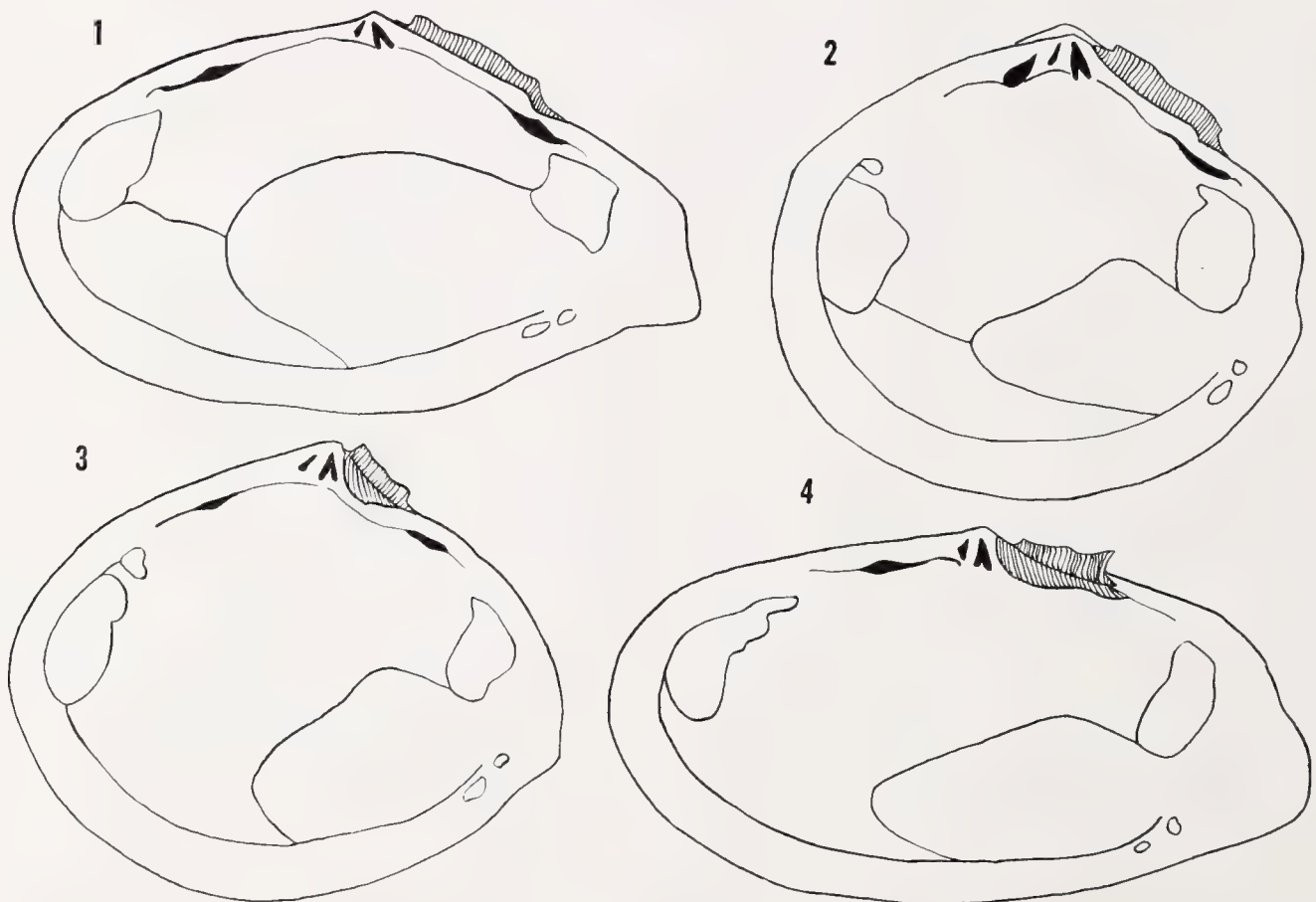


Plate 134. Figs. 1–4. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina listeri* Röding (about 1.2x) [L=60 mm.]. Fig. 2. *Tellina fausta* Pulteney (about 1.2x) [L=66 mm.]. Fig. 3. *Tellina laevigata* Linnaeus (about 1.3x) [L=45 mm.]. Fig. 4. *Tellina magna* Spengler (about 1.2x) [L=60 mm.].

(all MCZ). VIRGIN ISLANDS: Anegada Island, in 4–20 feet (ANSP); Virgin Gorda; Marine Cay, Tortola; White Bay and Monkey Point, Guana; St. Thomas; Altona, Lagoon, St. Croix (all MCZ). LESSER ANTILLES: St. Kitts (MCZ); St. Lucia, in 10 HISPANIOLA. HAITI: Baie des Flamands; Jérémie (both USNM); Miragoane (MCZ); SANTO DOMINGO: Siete Hermanos (USNM); Puerto Sosua; Monte Cristi; Puerto Plata fathoms; St. Vincent; Guadeloupe; Barbados (all USNM); Carriacou Island, Grenadines; Pigeon Point, Tobago (both MCZ). CARIBBEAN ISLANDS: Georgetown Harbor, Frank Sound Reef and Palmetto Point, Grand Cayman (all ANSP); Swan Island (MCZ). COLOMBIA: Covenas, off Bolivar; Cartagena; Santa Marta (all USNM). VENEZUELA: El Roque Island; Aruba Beach (both USNM). BRASIL: 150 miles NE of Bahia (MCZ).

Subgenus *Laciolina* Iredale

Scrobiculina Dall 1900, Proc. U.S. Nat. Mus., **23**: 290 (type species, *Scrobicularia viridotincta* 'Carpenter' Dall, *non* Carpenter 1864, original designation).¹

Laciolina Iredale 1937, Australian Zoologist, **8**(4): 241 (type species, *Tellina quoyi* Sowerby 1868, original designation).

Description. Shell medium to large in size, ovate to elliptical in shape, subsolid to solid, left valve somewhat inflated and with a flexure to the right posteriorly. Sculpture more or less smooth. Ligament of variable strength but with a strong thickened calcareous element subtended by a flattened nymphal callosity. Lateral teeth variously developed. In the right valve, both a subproximal anterior and a distal posterior lateral tooth present. In the left valve, the subproximal anterior lateral tooth developed; posterior lateral tooth developed or obsolete; rarely both laterals weak. Pallial sinus linguiform, pointed or rounded anteriorly and well separated from the anterior adductor muscle scar. Confluence of the pallial sinus with the pallial line limited to the posterior quarter of the valve.

The members of *Laciolina* tend to be rather large shelled and are therefore conspicuous. By and large, their simplest characterization rests in the structure of the ligament which possesses a typically thickened calcareous element. This internal portion of the ligament is greater in dorso-ventral proportion nearer the umbo and tapers posteriorly to the end of the nymph (see Plate 134, figs. 3–4). *Laciolina* has representatives in the tropical seas of the world, but it has not been discovered in the fossil record in the Western Atlantic.

KEY TO THE SPECIES OF *LACIOLINA* IN THE WESTERN ATLANTIC

1. Shell suborbicular; right posterior lateral dentition developed *laevigata*
 Shell elongate-elliptical; right posterior lateral dentition obsolete *magna*

***Tellina* (*Laciolina*) *laevigata* Linnaeus**

Plate 133, fig. 6; Plate 134, fig. 3

Tellina laevigata Linnaeus 1758, Systema Naturae, Ed. 10, p. 675 (In O Europaeo et Indico) [type locality, here restricted, Harrington Sound, Bermuda; type specimens, Collection of Linnean Society, London].

¹*Scrobularia viridotincta* Carpenter is macomoid in its morphological features. Dall's *Scrobiculina* has been given the rank of a junior synonym of *Psammotrete* (See Boss. 1964. The Veliger, **6**(4): 208–210).

Tellina concinna Philippi 1844, *Abbildungen und Beschreibungen Conchylier*, 1: p. 11, *Tellina*, pl. 2, fig. 1 (no locality) [type locality, here restricted, Harrington Sound, Bermuda; types not seen], *non concinna* Edwards 1847.

Tellina laevis 'Chemnitz' Krebs 1864, *The West Indian Marine Shells*, p. 102.

Tellina bayleana Bertin 1876, *Nouv. Arch. Mus.*, Paris, 2 ser., 1: 256, pl. 8, figs. 3a-b (Guadeloupe) [type specimens, L'Ecole des Mines, Paris].

Tellina (*Tellina*) *laevigata* Linnaeus. Dall 1900, *Proc. U.S. Nat. Mus.*, 23: 293.

Tellina laevigata stella Davis 1904, *Nautilus*, 17(11): 128, pl. 4, fig. 2 (Flatt's Inlet, Bermuda) [syntypes, ANSP, nos. 86921 and 109554].

Description. Shell reaching 94 mm. (about $3\frac{3}{4}$ inches) in length and 78 mm. (about 3 inches) in height, suborbicular, with a rather sharp posterior flexure to the right posteriorly. Valves thin, nearly fragile in young specimens. Umbos subcentral, elevated and pointed. Anterior margin broadly rounded; ventral margin with a postbasal arcuation; anterior dorsal margin gently sloping; posterior dorsal margin descending steeply; posterior margin nearly straight and forming a characteristic truncation. Sculpture consisting of regular concentric lines of growth which become heavy and coarse peripherally; radial lirations often present. Ligament dark brown to black and sunken. Calcareous portion of the ligament rather thick and supported by a nymphal callosity. In the left valve, the cardinal complex consists of an anterior elongate strong bifid tooth with the anterior lobe being much the larger, and of a posterior elongate laminate tooth; anterior lateral tooth weak and closer to the cardinal complex than the posterior tooth which is distal and well developed. In the right valve, the cardinal complex consists of a posterior thin bifid tooth with subequal lobes and of an anterior weak laminate tooth; the posterior lateral tooth is weaker and further removed from the cardinal complex than the strong, somewhat proximal anterior lateral tooth. Adductor muscle scars well impressed. Anterior and posterior adductor scars subequal and of a similar shape. Pallial sinus short, widely separated from the anterior adductor scar, rising only slightly and descending gently to a point more or less beneath the anterior lateral tooth where it falls abruptly to the pallial line; confluence short. Externally the shell is predominantly white in color but traces of yellow, fleshy-pink, orange and red are often evident either in a suffused or radial pattern.

length	height	width	
94 mm.	78 mm.	—	Bermuda
72	55	19 mm.	Lake Worth, Florida
57	40	14	Grand Bahama, Bahama Islands
57	45	16	Harrington Sound, Bermuda
43	34	12	St. Croix, Virgin Islands

Remarks. Among the characters of this species, none is as variable as the color and the pattern of color exhibited externally. The synonyms of *laevigata* have all been established on the basis of color. Some individuals are pure white, cream-yellow, or suffused with orange; others possess a peripheral band of similar colors while still others are variously rayed with orange, pink or red.

Tellina magna Spengler has been placed with *T. laevigata* in *Laciolina* because of the great similarity in the shape of the pallial sinus, the formation of the hinge and ligamental mechanisms and the disposition of the right anterior lateral tooth. From *magna*, *laevigata* is immediately separated by its orbicular shape, the radial dispensation of its coloration and the presence of a developed right posterior lateral tooth.

In the Eastern Pacific, *Tellina ochracea* Carpenter [= *viridotincta* of authors] is the nearest relative to *laevigata*; it is immediately separated by its distinctly thinner shell, and different coloration and proportions. *Tellina chloroleuca* Lamarck from the Philippines is closely related but is differentiated by its thinner shell, more elongate form, red umbos and somewhat sharper posterior flexure.

The fossil record of *Tellina laevigata* is not documented. In habit, it prefers relatively shallow water from depths of two feet to six fathoms; the usual substrate seems to be sand.

Range. This species has been found as far north as Beaufort Harbor, North Carolina. It occurs in Bermuda, throughout the Bahama Islands, and on the west coast of Florida as far north as Tampa Bay; it ranges southward through the Antilles to Venezuela.

Specimens examined. NORTH CAROLINA: Beaufort Harbor (ANSP); *Albatross I* station 2597, 20 miles ESE of Cape Hatteras (34°57' N; 75°43' W), in 15 fathoms (USNM). FLORIDA: Lake Worth; Bird Key, Biscayne Bay; Hawk Channel; Caesar's Creek Bank; Turtle Harbor (all USNM); Key West (MCZ); Charlotte Harbor; Tampa Bay (both USNM). BERMUDA: St. George; Castle Harbour; Trunk Island; Long Bay, Warwick (all MCZ). BAHAMA ISLANDS: Grand Bahama; Long Island; Turks Island (all MCZ). CUBA: Cape Cajon; Santa Rosa; Esperanza; Havana (all USNM); Matanzas; Cayo Frances, Caibarien; Punta Alegre, Camagüey (all MCZ). VIRGIN ISLANDS: Anegada; St. Thomas; St. Croix (all ANSP). LESSER ANTILLES: Barbados; Tobago (both MCZ). CARIBBEAN ISLANDS: Grand Cayman (ANSP). VENEZUELA: La Guaira (USNM); *Atlantis* Cruise 240, 30 miles N of Cabo Cadera, in 150 fathoms (MCZ).

***Tellina (Lacolina) magna* Spengler**

Plate 133, figs. 4–5; Plate 134, fig. 4

Tellina magna Spengler 1798, *Skrivter Naturhistorie-Selskabet*, 4(2): 76, p. 12, fig. 1 (Fra de Middelhavet) [type locality, here corrected and restricted, St. Croix, Virgin Islands; lectotype, here selected, Zoological Museum, Copenhagen].

Tellina acuta Wood 1815, *General Conchology*, p. 157, pl. 44, fig. 1 (West Indies) [type locality, here restricted, St. Croix, Virgin Islands; types not seen].

Tellina elliptica Lamarck 1818, *Animaux s. Vertèbres*, 5: 524 (provenance inconnue), [type locality, here restricted, St. Croix, Virgin Islands; holotype, Museum d'Histoire Naturelle, Paris], *non* Brocchi 1814, *nec* Sowerby 1867.

Tellina vitrea d'Orbigny 1842 [in] Sagra, *Hist. L'Ile Cuba*, Atlas, pl. 26, figs. 4–5; 1845, *Spanish Text*, 2(5): 304 (Guadeloupe); 1853, *French Text*, *Mollusques*, 2: 253 [holotype, BMNH, no. 54.10.4.510].

Tellina sol Hanley 1844, *Proc. Zool. Soc. London*, p. 142 (locality unknown) [type locality, here restricted, St. Croix, Virgin Islands; holotype, BMNH].

Phylloda sol Hanley. Bertin 1878. *Nouvelles Arch. Mus.*, Paris, 2 ser., 1: 329.

Tellina (Angulus) magna Spengler. Dall 1900, *Proc. U.S. Nat. Mus.*, 23: 295.

Tellina (Scrobiculina) magna Spengler, Warmke and Abbott 1961, *Caribbean Sea Shells*, p. 194.

Description. Shell extending to 122 mm. (about 4¾ inches) in length and to 65 mm. (about 2½ inches) in height, laterally compressed, not tumid and valves uniformly thin. Umbos just posterior to the middle and not inflated. Anterior margin smoothly rounded; ventral margin arcuate; anterior and posterior dorsal margins gently sloping. Shell sculptured with regularly and closely spaced concentric lines of growth which are stronger on the left valve and with extremely fine radial lirations which are most evident on the anterior slope. Ligament light brown in color with an exceptionally thick calcareous por-

tion which is sunken. In the left valve, the cardinal complex consists of an anterior strong deltoid bifid tooth with subequal lobes and of a thin posterior laminate tooth; lateral teeth totally absent or obsolete; rarely there is a weak proximal anterior tubercle. In the right valve, the cardinal complex consists of an elongate posterior bifid tooth with subequal lobes and a variously developed anterior laminate tooth; anterior lateral tooth well developed, small and proximal; posterior lateral absent or represented by an obsolete distal tubercle. Adductor muscle scars fairly well impressed. The posterior adductor muscle scar long, narrow and crescent shaped; the anterior adductor scar irregular. Pallial sinus short, shallow and constricted; its dorsal margin extends little above the ventral borders of the adductor scars; it is far removed posteriorly from the anterior adductor and confluent with the pallial line for about one third of its length. The pallial line swings sharply upward posteriorly and its terminus is far removed from the posterior margin of the shell. Externally the color may be white or fleshy-pink; often concentric alterations of color are evident as well as yellowish or pinkish rays emanating from the umbos. The right valve tends to be more strongly colored. The umbos are generally a rich golden yellow, often tending toward red. Internally the shell is mostly white with some suffusion of yellow radiating from the umbo.

length	height	width	
91.0 mm.	51.9 mm.	17.0 mm.	Lectotype of <i>magna</i> Spengler
20.5	11.0	3.6	Holotype of <i>vitrea</i> d'Orb.
96.0	58.8	17.2	Holotype of <i>sol</i> Hanley
122.0	65.0	22.0	Pass-a-grille, Florida
82.0	48.0	13.0	Trinity Bay, Martinique
22.0	10.5	3.5	Great Inagua, Bahamas

Remarks. This is one of the largest if not the largest of Western Atlantic tellins. Among the variable characters possessed by the species, the color and its pattern of distribution seems to be the greatest. Generally the shell is white with umbonal concentrations of yellow, fleshy-pink, orange or red; however, these colors in some individuals permeate the whole shell while in others they are disposed in a radial pattern emanating from the umbo. The hinge of *magna* is deeply inset and its calcareous portion very well developed. In respect to this character, *magna* may be compared with *laevigata*, *ochracea* of the Eastern Pacific and even *chloroleuca* of the Indo-Pacific, but its total lack of true lateral hinge dentition save for the right anterior lateral tooth precludes a too closely assigned relationship with *laevigata*. Dall (1900a) included this species in his diagnosis of *Angulus* and went on to say that though the species attained a large size, it agreed with the characteristics of *Angulus*; however, the strong, inset ligament and the subproximal, but quite well removed, right anterior lateral are unlike other species of *Angulus* and the nature of these characters alone places this species with *Laciolina*.

Ardeamia columbiensis (Hanley) of the Eastern Pacific is very close to *Tellina magna* in all its characteristics except in the complete lack of lateral dentition. It is probable that the great similarity in shape as well as the similarity of the configuration of the pallial sinus and of the ligamental structure are convergent. *Tellina magna* lacks the greenish-gray periostracum of *Ardeamia*.

Range. In the north, this species is found in Bermuda throughout the Bahamas, on the east coast of Florida as far north as Lake Worth and on the west coast of Florida as far north as Fort Walton. It ranges south through the Antilles to Martinique.

Specimens examined. FLORIDA: Peanut Island, Lake Worth; Grassy Key (both ANSP); Big Pine Key; Western Dry Rocks; Tortugas; Captiva; Long Key; Anne Marie Key; Pass-a-grille Beach (all MCZ); Anclote Keys; Cedar Keys (both USNM); Fort Walton (ANSP). BERMUDA: Castle Harbor; Trunk Island (both MCZ). BAHAMA ISLANDS: Grand Bahama; South Bimini Island; New Providence; Long Island; Great Inagua Island (all MCZ). CUBA: Habana; Cardenas (CNM); Punta Alegre, Camagüey (MCZ). VIRGIN ISLANDS: St. John (IMBPR); St. Croix (ANSP). LESSER ANTILLES: Trinity Bay, Martinique (BMNH). CARIBBEAN ISLANDS: Georgetown, Grand Cayman (ANSP).

Subgenus *Arcopagia* Brown

Arcopagia Brown 1827, Illustrations Conch. Great Britain and Ireland, pl. 16, fig. 8 (type species, *Tellina crassa* Pennant 1776, subsequent designation, Hermannson 1846, p. 76).

Cydicpe Leach 1852, Synopsis Moll. Great Britain, p. 314 (type species, *Cydicpe listeriana* Leach [= *Tellina crassa* Pennant], monotype), non Escholtz 1821.

Description. Shell medium to large in size, ovate, solid, equivalve and more or less equilateral. Lateral dentition well developed. In the right valve, both lateral teeth distinct and strong; posterior lateral tooth distal to cardinal complex and anterior lateral tooth subproximal or distal to the cardinal complex. Pallial sinus of various configurations. In the type, it rises obliquely and descends to the terminus of the pallial line so that no confluence occurs; however, the pallial sinus may be confluent with the pallial line for nearly all its length. Sometimes a linear scar connects the anterior adductor muscle scar and the pallial sinus.

Arcopagia in its broad sense is herein treated as a subgenus whereas some authors have used it as a full genus and many workers have divided it into numerous sections. Some traits which typify the group are unstable and liable to alteration among related species; however, the orbicular shape and general thickness of the valves typify the group. The lateral dentition is stronger in the right valve than in the left, and the position of these teeth is variable although the posterior lateral tooth is nearly always distally removed from the cardinal complex. The left lateral dentition is characterized by the obsolescence of the distal posterior tooth and by a variable placement of the anterior tooth.

The subgenus may be traced back to the Cretaceous (Stoliczka, 1870). Numerous species have been described in Cenozoic deposits. For example, the group is well represented in the Eocene of the Paris Basin. In the Recent fauna, the group appears to be most highly concentrated in the Indo-Pacific. Most species seem to prefer a tropical habitat, but there are some exceptions, for some species are temperate or even boreal in their distribution.

Tellina (*Arcopagia*) *fausta* Pulteney

Plate 134, fig. 2; Plate 135, figs. 1-2

Tellina remies 'Linnaeus' Born 1870, Museum Caesarum Vindobonensis, p. 36, pl. 2, fig. 11.

Tellina fausta Pulteney 1799, Catalogues of Dorsetshire, p. 92; 1813, 2 ed., p. 30, pl. 5, fig. 5 (British shore, Dorsetshire) [type locality, here corrected and restricted, Kingston, Jamaica; types lost].

Tellina laevis Wood 1815, General Conchology, p. 181, pl. 37, fig. 1 (West Indies) [type locality, here restricted, Kingston, Jamaica; types not seen].

Tellina (*Arcopagia*) *fausta* Donovan. H. and A. Adams 1856, Genera Recent Mollusca, 2: 396.

Tellina elliptica Sowerby 1868, Conch., Icon., 17, *Tellina*, pl. 43, fig. 251 (locality unknown), [type lo-

cality, here restricted, Kingston, Jamaica; holotype, BMNH, no. 1900.3.19.6], *non* Sowerby 1867, *nec* Brown 1814, *nec* Lamarek 1818, *nec* Brown 1827.

Tellina ellipsis Sowerby 1869, *Ibid.*, Index.

Cyclotellina (*Cyclotellina*) *fausta* Pulteney. Thiele 1935, *Handbuch Weichtierkunde*, 2: 915.

Arcopagia fausta Pulteney, Warmke and Abbott 1961, *Caribbean Seashells*, p. 197, pl. 4, fig. 1.



Plate 135. *Tellina fausta* Pulteney. Fig. 1. Internal view of the right valve, Biscayne Bay, Florida, MCZ 209049 (about 1.2x) [L=59 mm.]. Fig. 2. External view of the right valve, Tobago, West Indies, MCZ 143625 (about 1.1x) [L=64 mm.].

Description. Shell reaching 98 mm. (about 4 inches) in length and 90 mm. (about $3\frac{1}{2}$ inches) in height, suborbicular, solid and rather tumid. Umbos subcentral and somewhat inconspicuous. Anterior and ventral margins broadly rounded; anterior dorsal margin very gently sloping; posterior dorsal margin somewhat steep; posterior margin straight and forming a characteristic truncation. Sculpture consisting of somewhat irregularly spaced growth bands which have a tendency to become stronger on the anterior and posterior slope; an extremely fine, microscopic pattern of radial striae is evident. In the left valve, the cardinal complex consists of an anterior strong, slightly skewed bifid tooth and of a posterior thin, elongate laminate tooth; the anterior lateral tooth strong and proximal to the cardinal complex; the posterior lateral tooth distal and smaller than the anterior tooth. In the right valve, the cardinal complex consists of a posterior, skewed, strong bifid tooth and of an anterior elongate laminate tooth; the anterior lateral tooth proximally adjacent to the cardinal complex, protuberant and well developed. A strong internal rib extends radially from the umbo to the anterior adductor muscle scar. Ligament black or dark brown and protuberant. Calcareous element of the ligament subtended by a nymphal callosity. Adductor muscle scars well impressed. Anterior adductor scar large; posterior adductor scar irregularly oval. Pallial sinus not equal in opposite valves; pallial sinus in the left valve longer and closer to the anterior adductor scar than that of the right valve. The sinus rises sharply posteriorly but only for a short distance, then it descends gently anteriorly and falls to the pallial line far posteriorly; confluence short. Externally, the shell is usually a dull white. Internally polished and with traces of a pale yellow suffusion.

length	height	width	
26 mm.	20.8 mm.	9.5 mm.	Holotype of <i>elliptica</i> Sow.
98	90.0	40.0	New Providence, Bahamas
69	63.0	28.0	Punta Jorobado, Puerto Rico
30	26.0	12.0	Guantanamo, Cuba
17	8.0	6.0	Jamaica

Remarks. *Tellina fausta* is one of the largest of all Western Atlantic tellinids; it possesses the thickest, strongest and heaviest shell of all the species in that area and is quite distinguishable from all others on that basis alone. Its immediate ally and its closest relative, *Tellina remies* Linnaeus, occurs in the Indo-Pacific region. In *fausta*, the shell is more or less smooth whereas in *remies*, heavy, rounded, raised concentric sculpture is typical.

Dall (1900b, p. 1031) has documented the occurrence of *Tellina fausta* in the Pliocene marl of Caloosahatchie, Florida. He also listed a number of Eocene species from the Claibornian formation which may have some relationship with the ancestry of *fausta*.

In young individuals of *Tellina fausta*, the interior of the shell is often brightly colored with yellow and this coloration may show through externally. In adults, most of this external coloration is lost. There is present a brownish periostracum on living individuals.

Robertson (1961) has noted that *Tellina fausta* at Bimini lives in a coarse sand substrate at a depth of one foot, mostly among *Thalassia* rhizomes. Abbott (1958, p. 135) reported the occurrence of this species at Grand Cayman in water 4–6 feet deep over clear sand. The maximum depth record is 15 fathoms.

Range. This species is distributed from off the east coast of Florida near Lake Worth through the Florida Keys and the Bahamas, south to Tobago and the north coast of South America.

Specimens examined. NORTH CAROLINA: Cape Lookout (USNM). FLORIDA: Lake Worth (MCZ); Hillsboro Inlet (ANSP); Key Biscayne (CNM); Elliot's Key (MCZ); Rodriguez Island and Garden Cove, Key Largo (both ANSP); Grassy Key; Key Vaca; Bonefish Key; Boca Chica Key (all MCZ); Key West; Tortugas (both USNM). MEXICO: Veracruz; Isla del Carmen, Campeche (both MCZ). BRITISH HONDURAS: Belize (USNM; MCZ). HONDURAS: (BMNH). NICARAGUA: (ANSP). COSTA RICA: (ANSP). PANAMA: Mt. Hope (subfossil, ANSP); Brujas Point (MCZ); Cristobal; Colon; Fox River (all USNM). BERMUDA: Castle Harbor (subfossil, MCZ). BAHAMA ISLANDS: West End Point, Hawk's Bill Creek and Holmes Cay, Grand Bahama; Alicetown, North Bimini; Dick's Point, Nassau, New Providence; Eleuthera (all MCZ); Lisbon Creek Reef, Andros (USNM); Orange Creek and Little San Salvador, Cat Island (MCZ); Cockburn Town, Watlings Island; Exuma (both USNM); Long Island; Matthew Town, Great Inagua (both MCZ); Turks Island (USNM). CUBA: *Barrera* station 218, Cayo Hutia Reef; *Barrera* station 20, Santa Lucia, in 2–4 fathoms (both USNM); Jaimanitas, Habana (MCZ); Cayo Galendo, Cardenas Bay (ANSP); Cabanas Bay (USNM); Cayo Francés, Caibarien; Santa Maria Key, off Punta Alegre, Camagüey; Rancho Aluna, Cienfuegos Bay; Castillo de Jagua, Cienfuegos; mouth of Yateras River, Oriente; Guantánamo (all MCZ). JAMAICA: Green Island Harbour; Abingdon (both USNM); Montego (MCZ); Runaway Bay (USNM); Whitehouse Bay (MCZ); Ocho Rios; Port Maria; Jack's Bay; Robin's Bay; Harboreale, Annotta Bay; Port Antonio; Black River; Great Pedro Bay; Kingston; Buff Bay (all USNM); Pedro

Bank (MCZ); Port Royal; Palisadoes (both USNM). HISPANIOLA. HAITI: Cape Haitien (MCZ); Carpentier; Port au Prince (both USNM); Miragoane (MCZ); Jerémié; Baie Anglaise; Coteaux; Les Cayes (all USNM); Aquin (MCZ); Bizoton; Petit Groove; Saltrou (all USNM). SANTO DOMINGO: Siete Hermanos (USNM); Monte Cristi; Puerto Plata; Santa Bárbara de Samaná; Santo Domingo (all MCZ). PUERTO RICO: Mayaguez (MCZ); Porto Real (USNM); Cabo Rojo Light House (IMBPR); Ponce; Punta Jorobado; San Juan (all MCZ); Culebra Island (USNM); La Parquera (MCZ). VIRGIN ISLANDS: Loblolly Bay, Anegada (ANSP); Tortola (USNM); Monkey Point, Guana Island; Norman Island; St. Croix; St. Thomas (all MCZ). LESSER ANTILLES: Anguilla Island (BMNH); St. Martins (ANSP); Orange Bay, St. Eustatius Island (MCZ); St. Kitts (ANSP); Nevis Island (MCZ); Mill Reef Club, St. Philip, Antigua (MCZ); Falmouth Harbour, Antigua, in 3–6 fathoms (USNM); Guadeloupe; Martinique (BMNH); Villa, St. Vincent (USNM); Port Castries, St. Lucia (MCZ; USNM); Bathsheba and St. Lawrence, Barbados (both USNM); Maxwell's Coast, Barbados (MCZ); Grande Anse, Grenada (MCZ); Union, Admiralty Bay, Bequia Island and Carriacou Island, The Grenadines (both MCZ); Pigeon Point, Tobago (MCZ). CARIBBEAN ISLANDS: Gun Bay, Grand Cayman Island (ANSP); Swan Islands (USNM; MCZ); Aruba (USNM). COLOMBIA: Cartagena Bay (USNM; MCZ); Puerto Colombia (USNM). VENEZUELA: La Guaira (USNM).

Subgenus *Phyllodina* Dall

Phyllodina Dall 1900, Proc. U.S. Nat. Mus., 23: 290 (type species, *Tellina squamifera* Deshayes 1855, original designation).

Description. Shell of small and medium size, elongate-elliptical, mostly equilateral and equivalve. Umbo pointed, central to subcentral. Sculpture primarily concentric and sometimes differentiated posteriorly in the weakly flexed rostral area. Ligament short and somewhat sunken. Lateral dentition of right valve consisting of developed anterior and posterior lateral teeth distally placed in relation to the cardinal complex. Pallial sinus rising obliquely and falling obliquely to the pallial line; confluence short, limited to the posterior quarter of the ventral length of the pallial line. The pallial sinus is connected to the anterior adductor muscle scar by a linear scar.

The taxon *Phyllodina* of Dall forms a more or less natural group characterized by an obliquely rising, dorsally flattened, narrow and short pallial sinus which is connected with the anterior adductor scar by means of a single linear scar. The particular shape of the shell, being more or less elongate but not ovate, and the distinctive concentric sculpture circumscribe the whole group.

Phyllodina has representatives in the Miocene of North America and possessed a more northerly distribution during the Tertiary. It is represented by two species in the Eastern Pacific and two in the Western Atlantic, and there also are some Indo-Pacific representatives.

KEY TO SPECIES OF *PHYLLODINA* IN THE WESTERN ATLANTIC

1. Shell with spinose sculptural foliation along the posterior slope . . . *squamifera*
 Shell without spinosities posteriorly *persica*

***Tellina (Phyllodina) squamifera* Deshayes**

Plate 136, fig. 1; Plate 137, fig. 1; Plate 140, fig. 3

Tellina squamifera Deshayes 1855. Proc. Zool. Soc. London, **22**: 365 (Chinese Seas) [type locality, here corrected and restricted, off Miami Beach, Florida; holotype, BMNH].

Tellina (Arcopagia; Phyllodina) squamifera Deshayes. Dall 1900, Proc. U.S. Nat. Mus., **23**: 290.

Phylloda (Phyllodina) squamifera Deshayes. Thiele 1935, Handbuch Weichtierkunde, **2**: 918.

Phyllodina squamifera Deshayes. Olsson 1961, Panamic-Pacific Pelecypoda, p. 397.

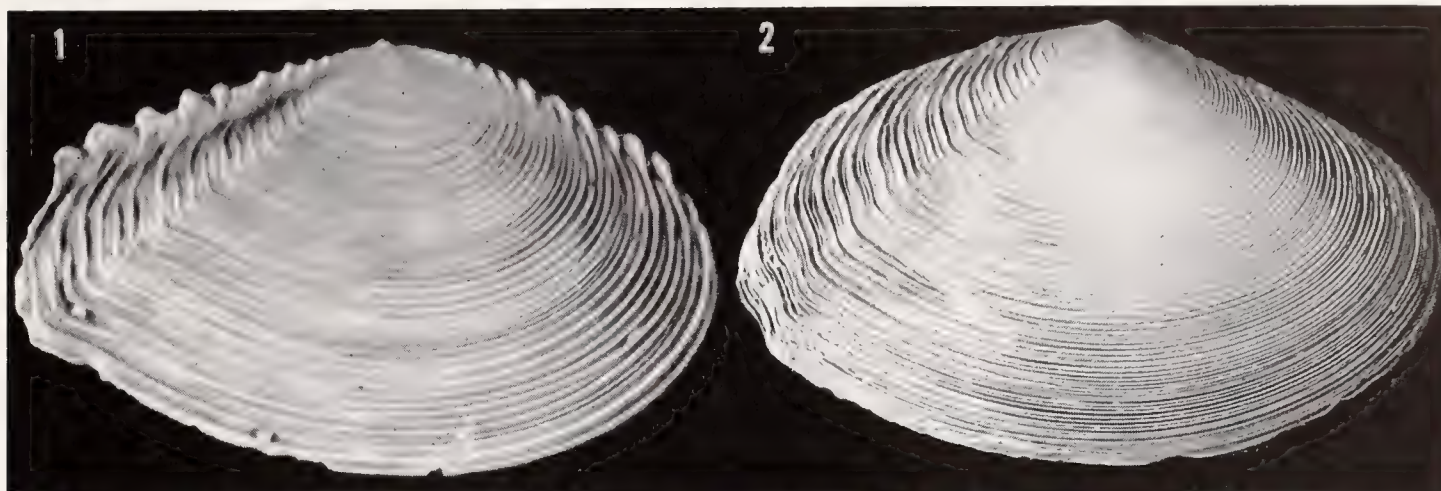


Plate 136. Fig. 1. *Tellina squamifera* Deshayes, external view of the right valve, off Sombrero Key, Florida MCZ 168730 (about 5x) [L=15.5 mm.]. Fig. 2. *Tellina persica* Dall and Simpson, external view of the right valve, Tobago, West Indies, MCZ 243066 (about 4.5x) [L=21.5 mm.].

Description. Shell extending to 26.8 mm. (about 1 inch) in length and to 16.4 mm. (about $\frac{1}{2}$ inch) in height, elongate, somewhat compressed with the left valve markedly more convex and with a strong flexure to the right posteriorly. Umbos small and pointed. Anterior margin smoothly and somewhat narrowly rounded; ventral margin convex, rising slightly posteriorly; anterior and posterior dorsal margins straight, subequal and gently sloping; posterior margin more or less straight, and forming an oblique truncation. Sculpture consisting of rather evenly spaced, slightly raised ribs separated by broad depressed bands; radial sculpture lacking. Strong posterior ridge developed in the right valve; concentric sculpture strongest on the posterior slope. The raised concentric ribs extend beyond the dorsal margin of the valve to form trigonal foliations which give the shell a serrate appearance. Ligament light to dark brown, short and protuberant. Calcareous element of the ligament subtended by a narrow, weak nymphal callosity. In the left valve, the cardinal complex consists of an anterior, elongate bifid tooth whose posterior lobe is the larger and of a posterior thin laminate tooth with a broadened base; anterior lateral tooth distal, weak and poorly developed; no true posterior lateral. In the right valve, the cardinal complex consists of a posterior strong subdeltoid bifid tooth with subequal lobes and of an anterior, thin, laminate tooth; anterior lateral distal, strong and well developed; posterior lateral distal, strong and well developed; the laterals are very long with grooves above. Adductor muscle scars poorly impressed. Pallial sinus rising obliquely, more or less flattened above and obliquely descending to the pallial line and uniting far posteriorly; it is connected to the anterior adductor scar by a short linear scar; confluence short. Externally the shell is white; internally, white suffused with yellow in the umbonal region and sometimes red or yellow on the posterior slope.

length	height	width	
20.8 mm.	12.0 mm.	4.7 mm.	Holotype of <i>squamifera</i> Deshayes
26.8	16.4	—	off Fowey Light, Florida
19.2	11.9	3.9	off Sombrero Key, Florida
11.7	6.9	2.3	off Miami, Florida
5.7	3.7	—	off Fowey Light, Florida

Remarks. This species may be at once separated from the nearest living ally in the Western Atlantic, *Tellina persica* Dall and Simpson, by its strong posterior dorsal foliations and its more coarse and raised concentric sculpture. In the Eastern Pacific, *squamifera* is most closely related to *T. pristiphora* Dall which is shorter and higher in the proportions of the shell. In addition, Dall has indicated that *pristiphora* is greenish whereas *squamifera* is usually white with suffusions of yellow and some red along the posterior slope. *Tellina leptalea* Gardner from the Shell Bluff, Shoal River formation of Florida is a Middle Miocene ancestor of *T. squamifera* and *T. dodona* Dall from the Miocene Oak Grove formation of Florida appears to be related to the lineage of both *T. squamifera* and *T. pristiphora*.

There is some variation in the thickness of the valves, especially in older individuals where the shell becomes quite solid. In some cases, the shell is less elongate than normal and it may become even somewhat subtrigonal. In immature stages, the shell has a slightly different form. The posterior truncation is broader, the shell tends to be vitreous, almost transparent, extremely fragile and thin, and the concentric growth lines are fewer, being wider and more undulate in immature specimens.

According to Parker (1960, p. 335), *Tellina squamifera* is a member of the 12–14 fathoms assemblage on sandy bottoms in the northern Gulf of Mexico,

Range. This species possesses a range which extends as far north as Cape Hatteras, North Carolina and south throughout the Florida Keys and Reefs, into the Gulf of Mexico and as far west as Texas and Mexico.

Specimens examined. NORTH CAROLINA: *Albatross I* station 2595, 22 miles ESE of Cape Hatteras (35°08' N; 75°05' W), in 63 fathoms (USNM). FLORIDA: off Palm Beach, in 50–100 fathoms (ANSP); off Miami, in 10–60 fathoms; off Fowey Light, in 25–125 fathoms; off Ragged Key; off Triumph Reef; off Ajax Reef; off Turtle Harbor (all USNM); off Sombrero Key, in 20–66 fathoms; off Looe Key, in 25–30 fathoms; off American Shoals, in 25–30 fathoms (all MCZ); off Sambo Reef; off Key West (both USNM); off Pelican Shoals, in 45 fathoms (MCZ); *Albatross I* station 2410, 80 miles N of Dry Tortugas (26°47' N; 83°25' W), in 28 fathoms; *Albatross I* station 2404, 35 miles S of Cape San Blas (28°44' N; 85°16' W), in 60 fathoms (both USNM). ALABAMA: *Albatross I* station 2367, 60 miles S of Mobile Bay 29°24' N; 88°04' W), in 32 fathoms (USNM). TEXAS: off Port Isabel, in 50 fathoms; 80–100 miles S of Port Isabel, in 40 fathoms (both MCZ).

***Tellina (Phyllodina) persica* Dall and Simpson**

Plate 136, fig. 2; Plate 137, fig. 2

Tellina (Arcopagia; Phyllodina) persica Dall and Simpson 1901, Bull. U.S. Fish. Comm., 20(1): 479, pl. 55, fig. 1 (Mayaguez Harbor, in 20–30 fathoms) [holotype, USNM, no. 159991].

Tellina (Arcopagia) persica Dall and Simpson. McLean 1951, N.Y. Acad. Sci., 17(1): 94.

Tellina (Eurytellina) persica Dall and Simpson. Warmke and Abbott 1961, Caribbean Seashells, p. 195, pl. 29, fig. g.

Description. Shell extending to 25 mm. (about 1 inch) in length and to 13 mm. (about ½ inch) in height, subquadrate, slightly inflated with the left valve slightly more convex and with a short but distinct posterior flexure to the right. Umbos central, small and markedly pointed. Anterior margin smoothly, but very narrowly rounded; ventral margin slightly convex and rising gently posteriorly; anterior dorsal margin gently sloping and straight; posterior dorsal margin somewhat convex, very gently sloping and short; posterior margin biangulate, with both portions straight and forming a rather blunt truncation. Sculpture consisting of raised concentric ribs rather evenly spaced and separated by narrow bands except on the posterior half of the right valve where the ribs become fewer, much stronger, lamellate and separated by wider bands. Radial sculpture consisting of exceedingly weak and faint lirations which are totally absent on the posterior half of the right valve. Ligament brown, strong and somewhat sunken. Calcareous portion of the ligament not strongly developed and subtended by weak nymphal callosities. In the left valve, the cardinal complex consists of an anterior strong deltoid bifid tooth whose posterior lobe is the stronger and of a posterior extremely well developed, elongate, subdeltoid laminate tooth; anterior lateral tooth distal, rather weak, but stronger than the distal obsolete posterior lateral. In the right valve, the cardinal complex consists of a posterior, skewed, strong, bifid tooth with subequal lobes and a well developed, short, anterior laminate tooth which is much weaker than the same in the opposite valve; anterior lateral tooth strong and distal; posterior lateral tooth stronger and distal. Adductor muscle scars rather poorly impressed. Anterior adductor muscle scar longer and narrower than the posterior. Pallial sinus rising abruptly and obliquely, flattened above, falling obliquely to and uniting with the pallial line far behind the anterior adductor scar; confluence short. A faint linear scar sometimes unites the anterior adductor scar with the pallial sinus. Externally and internally, the shell is white suffused with apricot, concentrated in the umbonal region and on the disc.

length	height	width	
20.6 mm.	12.7 mm.	5.8 mm.	Holotype of <i>persica</i> Dall and Simpson
24.2	13.2	5.8	Mayaguez, Puerto Rico
16.2	10.1	4.0	“ “ “
14.5	9.2	3.8	“ “ “
7.0	4.0	—	off Scarborough, Tobago

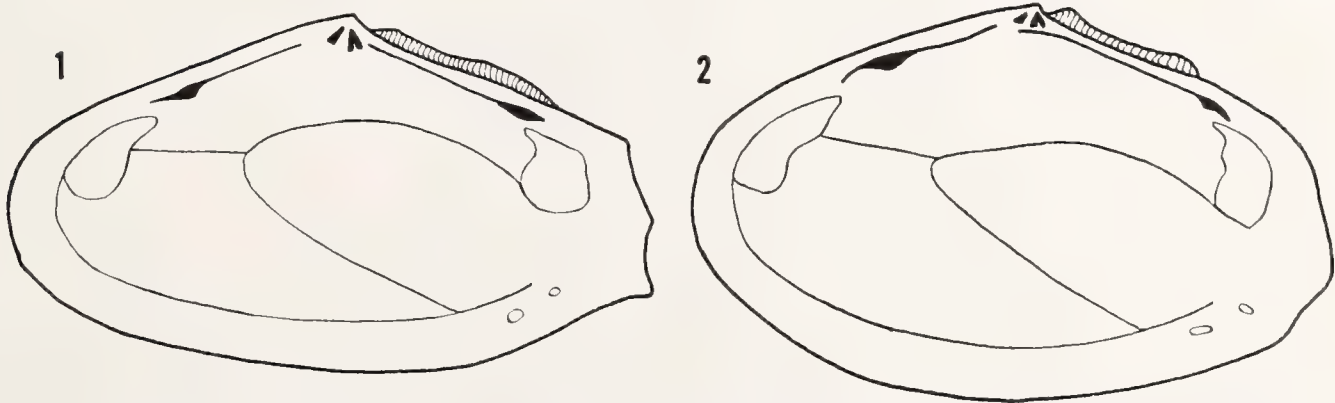


Plate 137. Figs. 1-2. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina squamifera* Deshayes (about 4.4x) [L=20 mm.]. Fig. 2. *Tellina persica* Dall and Simpson (about 4.2x) [L=21 mm.].

Remarks. By the paucity of material in various collections, *Tellina persica* may be judged to be a relatively rare species with a restricted distribution. In the Atlantic fauna, it is most closely related to *T. squamifera* Deshayes from which it may be immediately distinguished by its lack of posterior dorsal foliations, its subquadrate shape, and its smooth and regular concentric sculpture. It is also quite similar to the Eastern Pacific species, *T. fluctigera* Dall from which it can be separated by the nature of the umbos which are flat in *fluctigera*. In addition, *fluctigera* possesses slightly serrated anterior and posterior dorsal margins and a larger shell.

The fossil lineage of *Tellina persica* begins in the Miocene of the Bowden formation of Jamaica. *Tellina hallistrepia* Dall from the Bowden is virtually indistinguishable from the modern species. *Tellina francisca* Olsson from the Esmeraldas formation at Punta Gorda, Ecuador, which is of Late Miocene-early Pliocene age and an unnamed fossil species from Miocene of Limon, Costa Rica also belongs to the lineage of *T. persica*.

This species seems to be most variable in the character of its margins. The anterior margin is narrowly rounded in adults while in immature stages it may be broadly rounded. The ventral margin which is convex in the adult stage seems to be straight in the smaller and younger individuals. The species tends to be a deeper water one, having been taken in 30-50 fathoms off Puerto Rico.

Range. This species, rare as it appears to be, possesses a range which extends from a northern limit off Matanzas, Cuba to a southern boundary at Tobago, Lesser Antilles.

Specimens examined. CUBA: *Atlantis* station 2999, off Bahia de Matanzas (23°10' N; 81°11' W), in 145-230 fathoms; *Atlantis* station 3332, off Bahia de Cochinos (22°09' N; 81°11' W), in 175-225 fathoms (both MCZ). PUERTO RICO: *Fish Hawk* station 6062, Mayaguez, in 30 fathoms; *Fish Hawk* station 6064, Mayaguez, in 33 fathoms; Johnson-Smithsonian station 104¹, off Salinas Island (18°30' N; 66°13' W), in 50 fathoms (all USNM). LESSER ANTILLES: $\frac{3}{4}$ mile S of Fort St. Louis, Fort de France, Martinique, in 14-16 fathoms; 2 miles S of Scarborough, in 36 fathoms (both MCZ).

Subgenus *Elliptotellina* Cossmann

Elliptotellina Cossmann, Annales Societ  Royale Malacologique Belgique, 21: 58, pl. 4, figs. 5-6 (type species, *Donax tellinella* Lamarck 1805, original designation).

Description. Shell small, elliptical, inaequilateral, equivalve, and with both ends rounded. Sculpture consisting of concentric ribs and radial lirations variously distributed on the surface. The ligament is small, strong and subtended by a well developed nymphaal callosity. Hinge especially strong in the right valve; the right lateral teeth are subequal in strength and grooved above; the left lateral teeth are obsolete or absent. The pallial sinus is obliquely ascending and separated from the pallial line below except for an extremely short and posterior confluence.

The subgenus *Elliptotellina* was established for species occurring in the Eocene of the Paris Basin. Dall was the first to recognize the existence of two recent species in America. *Elliptotellina* is also represented in the Indo-Pacific by such species as *Tellina fabrefacta*

¹ The published record for this station (Bartsch, 1933, p. 29) is "the depth ranged from 80-100 fathoms." The catalog in the USNM reads for station 104, 50 fathoms.

Pilsbry from Japan. In the Western Atlantic, the fossil record may be traced to the Miocene.

***Tellina (Elliptotellina) americana* Dall**

Plate 149, fig. 6; Plate 155, fig. 4

Tellina (Elliptotellina) americana Dall 1900, Proc. U.S. Nat. Mus., **23**: 311, pl. 2, fig. 8 (*Albatross I* station 2612, off Cape Lookout, North Carolina ($34^{\circ}11' N$; $76^{\circ}10' W$), in 52 fathoms) [holotype, USNM, no. 92154].

Description. Shell extending to 8.5 mm. (about 5/16 inch) in length and to 5.5 mm. (about 3/16 inch) in height, elliptical, solid, inflated with the valves of an equal convexity and with a slight posterior flexure. Umbos small and rounded. Anterior margin smoothly and narrowly rounded; ventral margin convex and rising gently posteriorly; anterior dorsal margin long and convex; posterior dorsal margin short and straight; posterior margin forming an oblique truncation. Concentric sculpture consisting of evenly spaced, raised and rounded ribs. Radial sculpture absent from the anterior slope and disc but markedly evident on the posterior slope. Ligament brown, short, protuberant and subtended by short nymphal callosities. In the left valve, the cardinal complex consists of an anterior strong bifid tooth with subequal lobes and a small, thin posterior laminate tooth; no true laterals developed. In the right valve, the cardinal complex consists of a posterior skewed bifid tooth with subequal lobes and an anterior strong laminate; anterior and posterior lateral teeth distal, strong and well developed. Both laterals set on a strong hinge plate with grooves above. Adductor muscle scars poorly impressed. Anterior and posterior adductors rounded and subequal. Pallial sinus extending straight out from the base of the posterior adductor, flattened above, rounded behind and falling obliquely and almost parallel to the pallial line; sinus is far removed from the anterior adductor scar; confluence short. Shell predominantly white or pale straw color with a crimson or brown spot on the dorsal margin near each end.

length	height	width	
8.5 mm.	5.5 mm.	3.2 mm.	Holotype of <i>americana</i> Dall
8.2	5.1	3.3	off Miami, Florida
6.9	4.5	3.5	Lantana, Florida
5.4	3.3	2.0	off Miami, Florida

Remarks. *Tellina americana* is the only member of the subgenus in the recent fauna of the Atlantic. Its nearest living relative is *T. pacifica* Dall of the Eastern Pacific. In *americana*, the radial sculpture is localized on the posterior slope only and the obliquely ascending pallial sinus is shorter than that of *pacifica* where the radial sculpture may extend far anteriorly. Woodring (1925) has described *T. cymobia* from the Miocene of Jamaica which is the precursor of the recent *Elliptotellina*.

Range. This species possesses a range which extends from off Cape Lookout, North Carolina south through the Florida Keys to a southernmost point off Barbados. It has also been found in the Gulf of Mexico, off Horn Island, Mississippi.

Specimens examined. NORTH CAROLINA: *Albatross I* station 2612, off Cape Lookout ($34^{\circ}11' N$; $76^{\circ}10' W$), in 52 fathoms (USNM). FLORIDA: off Palm Beach; off Lantana, in 60 fathoms (both MCZ); off Miami, in 24–60 fathoms; off Fowey Light, in 25–70 fathoms; off Ajax Reef, in 40 fathoms; off Key West, in 90 fathoms; off Sand Key,

in 30–100 fathoms (all USNM). MISSISSIPPI: Horn Island (ANSP). LESSER ANTILLES: off Lazaretto and off Pelican Island, Barbados, in 75–95 fathoms (both USNM).

Subgenus *Merisca* Dall

Merisca Dall 1900, Proc. U.S. Nat. Mus., **23**: 290 (type species, *Tellina crystallina* Wood 1815 (= *Tellina cristallina* Spengler 1798), original designation).

Lyratellina Olsson 1961, Panamic-Pacific Pelecypoda. Paleontological Research Inst., Ithaca, N.Y., p. 383 (type species, *Tellina lyra* Hanley 1844, original designation).

Description. Shell medium to small in size, trigonal-subovate-subquadrate in shape and partially rostrate posteriorly. Umbos centrally placed. Sculpture consisting of variously spaced and strong concentric lirations. Lateral teeth developed in the right valve. Lateral dentition of the left valve obsolete or totally lacking. Pallial sinus extensive and sometimes coalescing with the anterior adductor muscle scar. Confluence of the pallial sinus and the pallial line generally complete but rarely the pallial sinus may parallel the pallial line for some distance before becoming confluent with it. Generally the shell is dull white in color.

Merisca as defined and utilized herein may well constitute a heterogeneous but closely related assemblage of species. For example, *Merisca* closely approaches *Quadrans*, as represented in its type *Tellina gargadia* Linnaeus of the Indo-Pacific. In shell shape, concentric sculpture and in the development of the lateral dentition of the left valve, *Quadrans* possesses some differences to the Western Atlantic species of *Merisca*, *Tellina aequistriata* and *T. alerta*, which resemble it most closely. Likewise, *Tellina juttingae* might be compared to *Tellina lyra* Hanley and *T. lyrica* Pilsbry and Lowe from the Eastern Pacific, species for which Olsson (1961) erected the new genus, *Lyratellina*. The Eastern Pacific species have also been referred to Cossmann's *Macaliopsis*, which is based upon *Tellina barrandei* Deshayes, an Eocene species from the Paris Basin. Olsson considers the similarity of *Lyratellina* to *Macaliopsis* to be merely superficial. One of the major distinguishing traits of both *Lyratellina* and *Macaliopsis* is that the umbos are prosogyrous. However, the prosogyrate condition of the umbos is an inconstant trait and in such species as *Tellina martinicensis* of the Western Atlantic the umbos may vary in orientation from the orthogyrate to the prosogyrate position. *Merisca* is represented in the Atlantic, Pacific and Indian Oceans. Although a number of species extend into the more temperate zones, most are concentrated in the tropics. The group is well established in the Eocene.

KEY TO SPECIES OF *MERISCA* IN THE WESTERN ATLANTIC

1. Right anterior lateral tooth subproximal to the cardinal complex *cristallina*
Right lateral teeth more or less equidistant from the cardinal complex 2
2. Pallial sinus extending parallel to the pallial line for about half its length before becoming confluent 3
Pallial sinus uniting with the pallial line without paralleling it 4
3. Anterior dorsal margin short and deeply concave *juttingae*
Anterior dorsal margin long and weakly concave *martinicensis*
4. Pallial sinus uniting with the pallial line very near the base of the anterior adductor muscle scar *aequistriata*
Pallial sinus well removed from the anterior adductor muscle scar and uniting with the pallial line in the posterior portion of the valve *alerta*

***Tellina (Merisca) cristallina* Spengler**

Plate 138, fig. 5; Plate 139, fig. 6

Tellina cristallina Spengler 1798, Skrivter Naturhistorie Selskabet, 4(2): 113 (Newport, Long Island) [type locality, here corrected, St. Thomas, Virgin Islands; holotype, Zoological Museum, Copenhagen].

Tellina crystallina Wood 1815, General Conchology, p. 149 (no locality given) [refers to Chemnitz, Conch. Cab. (1), 11: 210, pl. 199, fig. 1947, 1948].

Tellina schrammi Récluz 1853, Jour. de Conchy., 4: 152, pl. 6, figs. 7-8 (Point-a-Pitre, Guadeloupe) [types not seen].

Tellina (Merisca) crystallina Wood. Dall 1900, Proc. U.S. Nat. Mus., 23: 293.

Tellina (Merisca) cristallina Spengler, Warmke and Abbott 1961, Caribbean Seashells, p. 196, pl. 40, fig. b.

Description. Shell extending to 24 mm. (about 1 inch) in length and to 18 mm. (about $\frac{3}{4}$ inch) in height, ovate-subtrigonal, produced posteriorly, rather compressed with the left valve somewhat convex and the right valve concave or flattened and with a strong and marked posterior flexure to the right. Umbos central and conspicuous. Anterior margin broadly rounded; ventral margin convex and rising posteriorly; anterior and

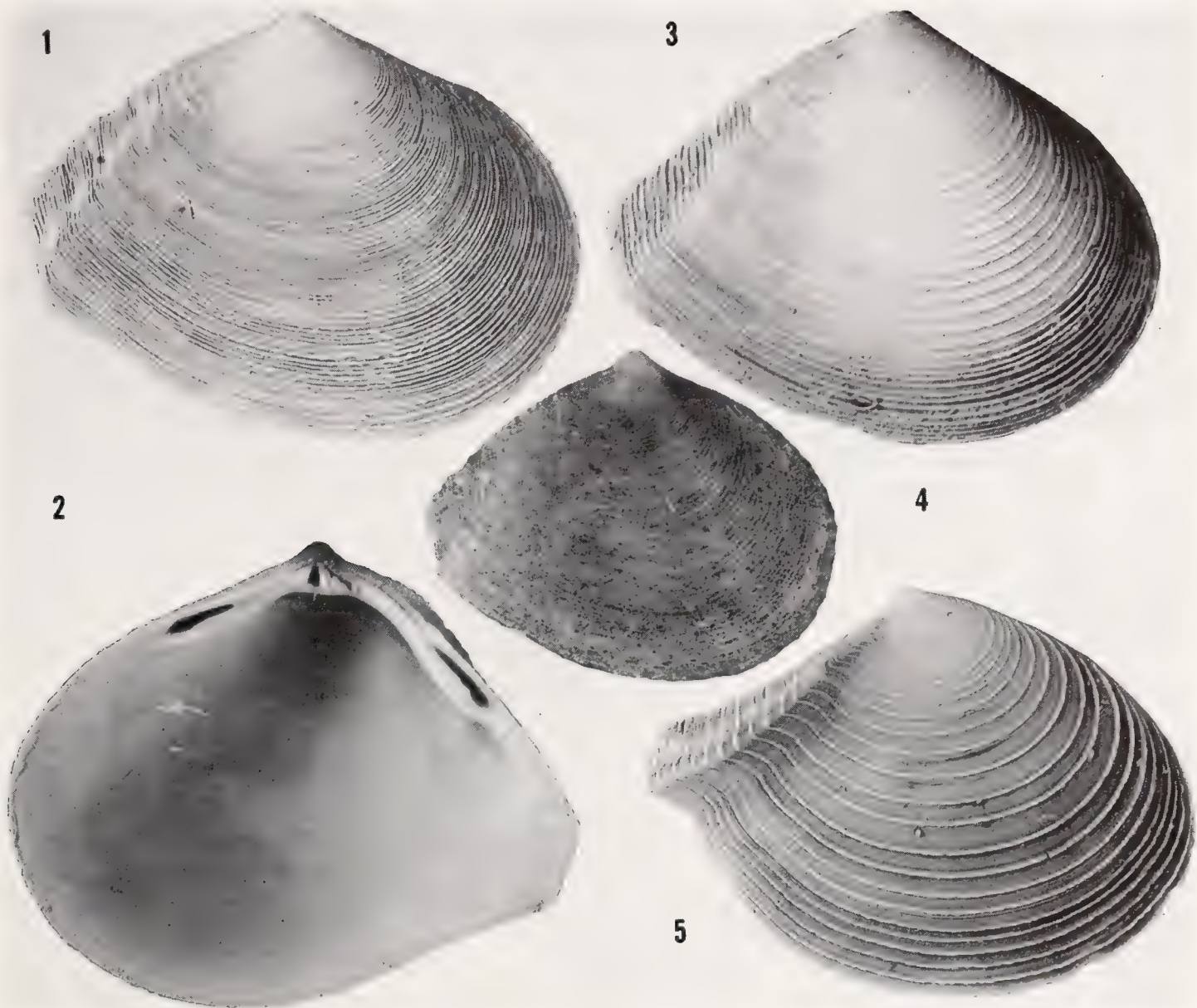


Plate 138. Figs. 1-4. *Tellina martinicensis* d'Orbigny. Fig. 1. External view of the right valve, Tobago, West Indies, MCZ 243067 (about 5.8x) [L=12 mm.]. Fig. 2. Internal view of the right valve, Puerto Rico, MCZ 243128 (about 6.4x) [L=11 mm.]. Fig. 3. External view of the right valve, Puerto Rico, MCZ 243128 (about 8x) [L=8.5 mm.]. Fig. 4. External view of the right valve of a syntype, Martinique, BMNH (about 6x) [L=7.5 mm.]. Fig. 5. *Tellina cristallina* Spengler, external view of the right valve, Bahia Bramadero, Puerto Rico, MCZ 243127 (about 3x) [L=24 mm.].

posterior dorsal margin long and steeply descending; posterior margin short, straight and giving the shell a truncate appearance. Sculpture consisting of strong, widely spaced concentric ridges separated by broad flattened bands; no true radial sculpture evident. Posterior ridges and sulci in both valves. Ligament brown and somewhat sunken. Calcareous element of the ligament small and not supported by a raised nymphal callosity. In the left valve, the cardinal complex consists of an anterior, narrow and elongate bifid tooth, with the anterior lobe the larger and of a posterior and elongate laminate tooth; anterior lateral tooth weak, obsolete and subproximal to the cardinal complex; posterior lateral stronger, thin and distal to the cardinal complex. In the right valve, the cardinal complex consists of a posterior elongate, slightly skewed bifid tooth with the anterior lobe the larger and of an anterior long laminate tooth; the anterior lateral tooth is subproximal to the cardinal complex, rather well developed, but weaker than the distal posterior lateral tooth. Adductor muscle scars poorly impressed. Anterior adductor elongate, narrow and lunate; posterior adductor irregularly circular. Pallial sinus dissimilar in opposite valves, generally rising to an apex, descending gently and uniting with the pallial line close to the anterior adductor. The shell is thin, rather opaque, lustreless and white.

length	height	width	
24 mm.	18 mm.	—	Cartagena, Colombia
24	17	6 mm.	St. Thomas
22	16	5	Barcelona Beach, Venezuela
12	8	—	Baie Anglaise, Haiti

Remarks. The holotype of *Tellina cristallina* Spengler consists of a broken right valve and is preserved in the Zoological Museum of Copenhagen. The type locality originally given was Newport, Long Island [Rhode Island] and is in error since the species does not range that far north. In all probability, the original specimen came from the then Danish West Indies and for this reason, the type locality is here corrected to St. Thomas, Virgin Islands. Some early workers considered that this species was Eastern Pacific whereas Dall (1900a) contended that it was distributed in both the Atlantic and the Pacific. Recently Olsson (1961) has considered the problem and arrived at a satisfactory result, for he has been able to separate a distinct Eastern Pacific analog of *cristallina*. In contrast to *Tellina* (*Merisca*) *rhynchoscuta* Olsson of the Eastern Pacific, *cristallina* may be distinguished by its straight anterior and posterior dorsal margins. Olsson has also noted that *rhynchoscuta* has heavier, more stubby valves, stronger and coarser concentric sculpture and a deeper sulcus which extends in front of the rostral ridges.

Tellina cristallina has been discovered in the Pliocene and Miocene strata of the Western Atlantic. Maury (1917) has documented its occurrence in the Miocene of Santo Domingo. *Tellina sancti-dominici*, closely allied to *cristallina* but no longer living in the modern fauna, was also described by Maury from the Miocene of Santo Domingo. According to Hertlein and Strong (1949), Lynge (1909) described an Indo-Pacific species, *Tellina martensi*, which may be distinguished from *cristallina* by its less rostrate shell; unfortunately no specimens of *martensi* have been available for study.

Range. This species ranges from Sullivan's Island, South Carolina through the Greater Antilles and Virgin Islands. It also occurs on the eastern coast of Central America and on the northern coast of South America.

Specimens examined. SOUTH CAROLINA: Sullivan's Island (USNM). GUATEMALA: (BMNH). JAMAICA: Black River, St. Elizabeth (USNM). HISPANIOLA. HAITI: Jerémié; Baie Anglaise (both USNM). SANTO DOMINGO: Monte Cristi; Puerto Plata (both MCZ). PUERTO RICO: Bahia Bramadero (IMPBR). VIRGIN ISLANDS: St. Thomas (USNM). COLOMBIA: Cartagena (MCZ). VENEZUELA: Barcelona (USNM); Margarita Island (ANSP).

Tellina (Merisca) martinicensis d'Orbigny
Plate 138, figs. 1–4; Plate 139, fig. 5

Tellina martinicensis d'Orbigny 1942 [in] Sagra, Hist. L'Ile Cuba, Atlas, pl. 26, figs. 6–9; 1845, Spanish Text, 2(5): 305; (Martinica y la Guadalupe); 1853, French Text, Mollusques, 2: 253 [type locality, here restricted, Martinique; syntypes, BMNH, no. 54.10.4.511].

- Tellina (Moerella) martinicensis* d'Orbigny. Dall, 1900 Proc. U.S. Nat. Mus., 23: 295.
Tellina (Moerella) obtusa 'Sowerby' Dall 1900, Proc. U.S. Nat. Mus., 23: 295, *non* Sowerby 1817, *nec* Sowerby 1868.
Tellina (Moerella) tumida 'Sowerby' Dall 1900, Proc. U.S. Nat. Mus., 23: 295, *non* Sowerby 1867.
Tellina (Tellinella) versluysi Dautzenberg 1900, Mem. Soc. Zool., Paris, 13: 115, pl. 10, fig. 5 (Santa Marta Colombia; syntypes, Dautzenberg collection, Institut Royal des Sciences Naturelles, Bruxelles).¹
Tellina (Eurytellina) martinicensis d'Orbigny. Dall and Simpson 1901, Bull. U.S. Fish. Comm., 20(1): 480.
Tellina (Merisca) martinicensis d'Orbigny. Warmke and Abbott 1961, Caribbean Seashells, p. 196, pl. 40 i.

Description. Shell extending to 12.2 mm. (about ½ inch) in length and to 10.1 mm. (about ¾ inch) in height, ovate, solid, slightly produced posteriorly, inflated with valves of equal convexity and with a strong posterior flexure to the right. Umbos subcentral, inflated and blunt. Anterior margin broadly rounded; ventral margin convex and with a strong postbasal arcuation; anterior dorsal margin gently sloping and straight; posterior dorsal margin long, steeply sloping and convex; posterior margin short, straight and forming an oblique truncation. Sculpture consisting of raised and strong concentric ridges (about 4 per millimeter) separated by broad bands. No radial sculpture. Ligament brown, inconspicuous and sunken; no true nymphal callosities. In the left valve, the cardinal complex consists of an anterior strong bifid tooth with subequal lobes and of a posterior protuberant laminate tooth; both lateral teeth consisting of localized thickenings of the hinge plate. In the right valve, the cardinal complex consists of a posterior strong bifid tooth with subequal lobes and of an anterior thickened laminate tooth; both laterals strong. Adductor muscle scars not well impressed. The anterior adductor elongate and narrow; posterior adductor rounded. Pallial sinus more or less equal in both valves, rising high posteriorly, rounded and extending far anteriorly, nearly to the anterior adductor scar, arcuate ventrally and extending parallel to the pallial line for nearly one half its ventral length; confluence short. Shell white and rarely iridescent.

length	height	width	
12.2 mm.	10.1 mm.	—	Santa Lucia, Cuba
10.0	8.5	5.5 mm.	Florida
9.0	7.0	4.0	Mayaguez, Puerto Rico
8.1	6.4	3.2	Bahia de Samana, Santo Domingo

Remarks. In the Western Atlantic, *Tellina martinicensis* appears to be most closely

¹ The author is indebted to Dr. C. O. van Regteren Altena of the Rijksmuseum van Natuurlijke Historie, Leiden for checking the syntypes of the Dautzenberg species.

related to the rare *Tellina juttingae*. It never attains the great size exhibited by *juttingae*, which appears to be four or five times greater in its dimensions. In addition, the anterior dorsal margin of *juttingae* is strongly convex and the umbo appears to be prosogyrous, although this latter characteristic appears rarely in *martinicensis*.

Tellina aequistriata Say may be confused with *martinicensis*; however, in the latter, the shell is more tumid, the umbos higher, and the concentric sculpture stronger. The

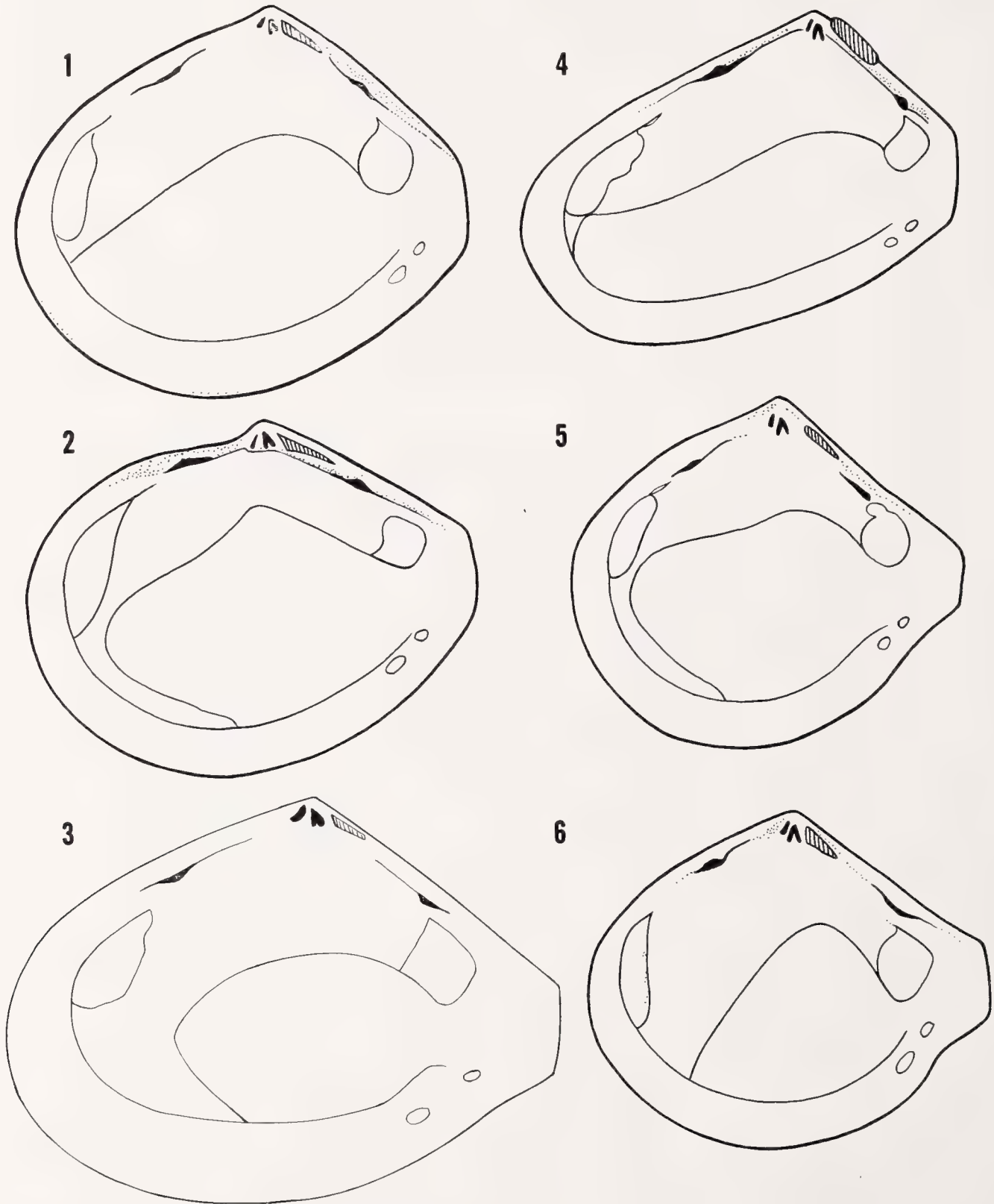


Plate 139. Figs. 1-6. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina aequistriata* Say (about 3x) [L=21 mm.]. Fig. 2. *Tellina juttingae* Altena (about 3x) [L=22 mm.]. Fig. 3. *Tellina alerta* Boss (about 10x) [L=8 mm.]. Fig. 4. *Tellina gouldii* Hanley (about 7x) [L=9 mm.]. Fig. 5. *Tellina martinicensis* d'Orbigny (about 4.5x) [L=12 mm.]. Fig. 6. *Tellina cristallina* Spengler (about 4.4x) [L=20.].

species are distinct with regard to the pallial sinus. In *martinicensis*, the sinus unites with the pallial line posteriorly and in *acquistriata* it is confluent at or near the base of the anterior adductor muscle scar.

The earliest precursor to *Tellina martinicensis* occurs in the Miocene of the Bowden marls of Jamaica. Woodring (1925) has described *Tellina sclera lerasca* which exhibits a similarity of dentition, sculpture and tumidity. The recent species is also represented by *Tellina caloosana* in the Pliocene of the Caloosahatchee in Florida (Dall, 1900b). In the Eastern Pacific, *Tellina proclivis* Hertlein and Strong appears to be the analog of *Tellina martinicensis*.

Range. This species is found from Tampa Bay, Florida south through the Greater and Lesser Antilles to Scarborough, Tobago.

Specimens examined. FLORIDA: off Main Channel, Key West, in 10–20 fathoms; Western Dry Rocks (both MCZ); Tortugas, in 15 fathoms (USNM); Gulfport, Tampa Bay (ANSP). BRITISH HONDURAS: Belize; Monkey River (both ANSP). PANAMA: Mt. Hope (Pleistocene, ANSP). CUBA: *Barrera* station 209, Santa Rosa, in 3–6 fathoms; *Barrera* station 200, Santa Lucia, in 2–4 fathoms; *Barrera* station 208, Bahía Honda, in 1–12 fathoms; *Barrera* station 203, Cabanas Harbor, in 3–12 fathoms; *Barrera* station 212, Cardenas Bay, in 1–3 fathoms (all USNM). JAMAICA: (MCZ). HISPANIOLA. SANTO DOMINGO: Puerto Plata (ANSP); Santa Barbara de Samana (USNM). PUERTO RICO: Mayagüez; off Enrique Reef, La Parguera, in 30–75 feet (both IMPBR); San Juan Harbor, in 5 fathoms (USNM). VIRGIN ISLANDS: St. Thomas (ANSP). LESSER ANTILLES: $\frac{3}{4}$ mile S of Fort St. Louis, Martinique (MCZ); Carlisle Bay, Barbados, in 12 fathoms (USNM); 2 miles S of Fort George, Scarborough, Tobago (MCZ).

***Tellina (Merisca) juttingae* Altena**

Plate 139, fig. 2; Plate 140, figs. 1–2

Lyratellina juttingae Altena 1965, *Basteria*, 29: 52–54, figs. 1a–e (N of the mouth of the Surinam River, 20 miles off the coast, at 15 fathoms; holotype, Rijksmuseum van Natuurlijke Historie, Leiden).

Description. Shell extending to 28.5 mm. (about $1\frac{1}{8}$ inches) in length and to 21 mm. (about 3.4 inches) in height, elongate-subquadrate, with both valves of more or less equal convexity and with a very weak flexure to the right. Umbos subcentral, prosogyrous and pointed. Anterior margin broadly rounded; ventral margin broadly arcuate and rising posteriorly; anterior dorsal margin falling abruptly from the umbonal region and distinctly concave; posterior dorsal margin rather steeply inclined and long; posterior margin short and straight, forming a blunt truncation. Sculpture consisting of broadly and evenly spaced slightly raised ridges (2–4 per millimeter), separated by broad flat bands; no radial sculpture. Ligament not observed; no nymphal callosities. In the left valve, the cardinal complex consists of an anterior small and weak bifid tooth with subequal lobes and of a posterior thin laminate tooth; no true anterior lateral tooth; posterior lateral absent or obsolete. In the right valve, the cardinal complex consists of a posterior, small subdeltoid bifid tooth with the posterior lobe the larger and of an anterior thickened laminate tooth; anterior and posterior lateral teeth well developed, distal to the cardinal complex, subequal in strength and with sockets above. Adductor muscle scars moderately impressed. Anterior adductor scar elongate and narrow; posterior adductor

transversely quadrate. Pallial sinus extensive, rising abruptly behind, extending in a broad arcuation anteriorly but not touching the anterior scar; the sinus parallels the pallial line ventrally and unites posteriorly; confluence short. Shell white, partly covered with an olivaceous gray periostracum, rarely iridescent.

length	width	
28.5 mm.	21 mm.	Trinidad
25.5	19	"
23.0	17	"
22.5	16	"



Plate 140. Figs. 1-2. *Tellina juttingae* Altena. Fig. 1. Internal view of the right valve, Trinidad, MCZ 239112 (about 3.4x) [L=22.5 mm.]. Fig. 2. External view of the right valve, Trinidad, MCZ 239112 (about 3.4x) [L=23 mm.]. Fig. 3. *Tellina squamifera* Deshayes, external view of the right valve of the holotype, 'Chinese Seas', BMNH (about 5.5x) [L=20.8 mm.].

Remarks. This species is extremely rare. The shell is rather thin, rounded in front, and bluntly truncated behind; the peculiar shape of the anterior dorsal margin is certainly diagnostic. Of the Western Atlantic tellins, *Tellina martinicensis* is most closely related. The dentition, the external sculpture and the configuration of the pallial sinus in *martinicensis* are quite similar to *juttingae*; however, *juttingae* attains a much greater size. In contrast to *juttingae*, the shell is thicker, the postbasal arcuation stronger and the posterior truncation shorter in *martinicensis*. *Tellina lyra* Hanley is the Eastern Pacific analog of *juttingae*.

Range. This species occurs from off Surinam to Trinidad.

Specimens examined. TRINIDAD: Saut d'Eau Bay, in 10–20 fathoms (MCZ). SOUTH AMERICA: N of the mouth of the Surinam River (Rijksmuseum, Leiden).

***Tellina (Merisca) aequistriata* Say**

Plate 139, fig. 1; Plate 141, figs. 1–2; Plate 142, figs. 1–3

Tellina aequistriata Say 1824, Jour. Acad. Nat. Sci., Philadelphia, 4: 145, pl. 10, fig. 7 (Maryland, Miocene) [types lost], *non* Sowerby 1868.

Tellina lintea Conrad 1837, Jour. Acad. Nat. Sci., Philadelphia, 7: 259, pl. 20, fig. 3 (Mobile Point, Alabama) [types lost], *non* Conrad 1848, *nec* Hutton 1873.

Tellina guadalupensis d'Orbigny 1842 [in] Sagra, Hist. L'Ile Cuba, Atlas, pl. 26, figs. 1–3 (Guadeloupe) [holotype, BMNH, no. 54.10.4.508].

Tellina guadalupensis d'Orbigny 1845 [in] Sagra, Hist. Isla Cuba, Spanish Text, 2(5): 304, error for *guadalupensis* d'Orbigny.

Tellina guadalupiensis d'Orbigny 1853 [in] Sagra, Hist. L'Ile Cuba, Mollusques, French Text, 2: 253, error for *guadalupensis* d'Orbigny.

Tellina tumida Sowerby 1867 [in] Reeve, Conch. Icon., 17, *Tellina*, pl. 23, figs. 120a and b (Jamaica) [holotype, BMNH, no. 67.10.7.18].

Tellina (Tellinella) ostracea 'Lamarck' Dautzenberg 1900, Mem. Soc. Zool., Paris, 13: 259, *non* Lamarck 1818.

Tellina (Merisca) aequistriata Say. Dall 1900, Trans. Wagner Free Inst. Sci., Philadelphia, 3(5): 1020.

Tellina (Merisca) lintea Conrad. Dall 1900, Proc. U.S. Nat. Mus., 23: 293.

Quadrans lintea Conrad. Warmke and Abbott 1961, Caribbean Seashells, p. 198, pl. 41 k.

Description. Shell extending to 24.5 mm. (about 1 inch) in length and to 19 mm. (about $\frac{3}{4}$ inch) in height, subrhomboid, produced behind, subsolid, with the left valve markedly more convex and with a strong, sharp posterior flexure to the right. Umbos nearly central and pointed. Anterior margin broadly rounded; ventral margin arcuate, convex and rising posteriorly; anterior dorsal margin long and gently sloping; posterior dorsal margin straight and steeply inclined; posterior margin short, straight and forming a truncation. Sculpture consisting of raised, more or less sharp and evenly spaced concentric ridges (4–8 per millimeter), separated by rather broad sulci; no radial sculpture. Ligament light yellow to dark brown, inconspicuous and sunken. Calcareous element of the ligament short and resting on the flattened hinge plate; no true nymphal callosities. In the left valve, the cardinal complex consists of an anterior elongate bifid tooth with thin subequal lobes and of a posterior elongate and somewhat curved laminate tooth; both lateral teeth poorly developed, posterior one distal. In the right valve, the cardinal complex consists of a posterior elongate strong bifid tooth with subequal lobes and of an anterior elongate and thickened laminate tooth; the lateral teeth strong, distal to the cardinal complex and socketed. Adductor muscle scars well impressed. Anterior adductor dorsoventrally elongate and lunate; posterior adductor quadrate. Pallial sinus equal in opposite valves, rising abruptly behind, rounded above, descending gently without an anterior arcuation and uniting with the pallial line just beneath the anterior adductor scar; confluence entire. Shell white, sometimes covered by an adhering brownish periostracum.

length	height	width	
9.5 mm.	6.9 mm.	3.3 mm.	Holotype of <i>guadalupensis</i> d'Orb.
24.5	19.0	—	off Cape Hatteras, North Carolina
16.0	11.5	6.0	Pass Cabello, Texas
4.6	3.1	—	Matanzas Bay, Cuba

Remarks. The fossil history of *Tellina aequistriata* extends back to the Miocene and there are ample records of the occurrence of this species in North American strata. Dall (1900b) and Mansfield (1932) have documented the fossil records for this species from Virginia, North Carolina, South Carolina and Florida. In addition, Woodring (1925) has listed *Tellina acrocosmia* Dall, which is a predecessor of *Tellina aequistriata*, from the Bowden marls of Jamaica.

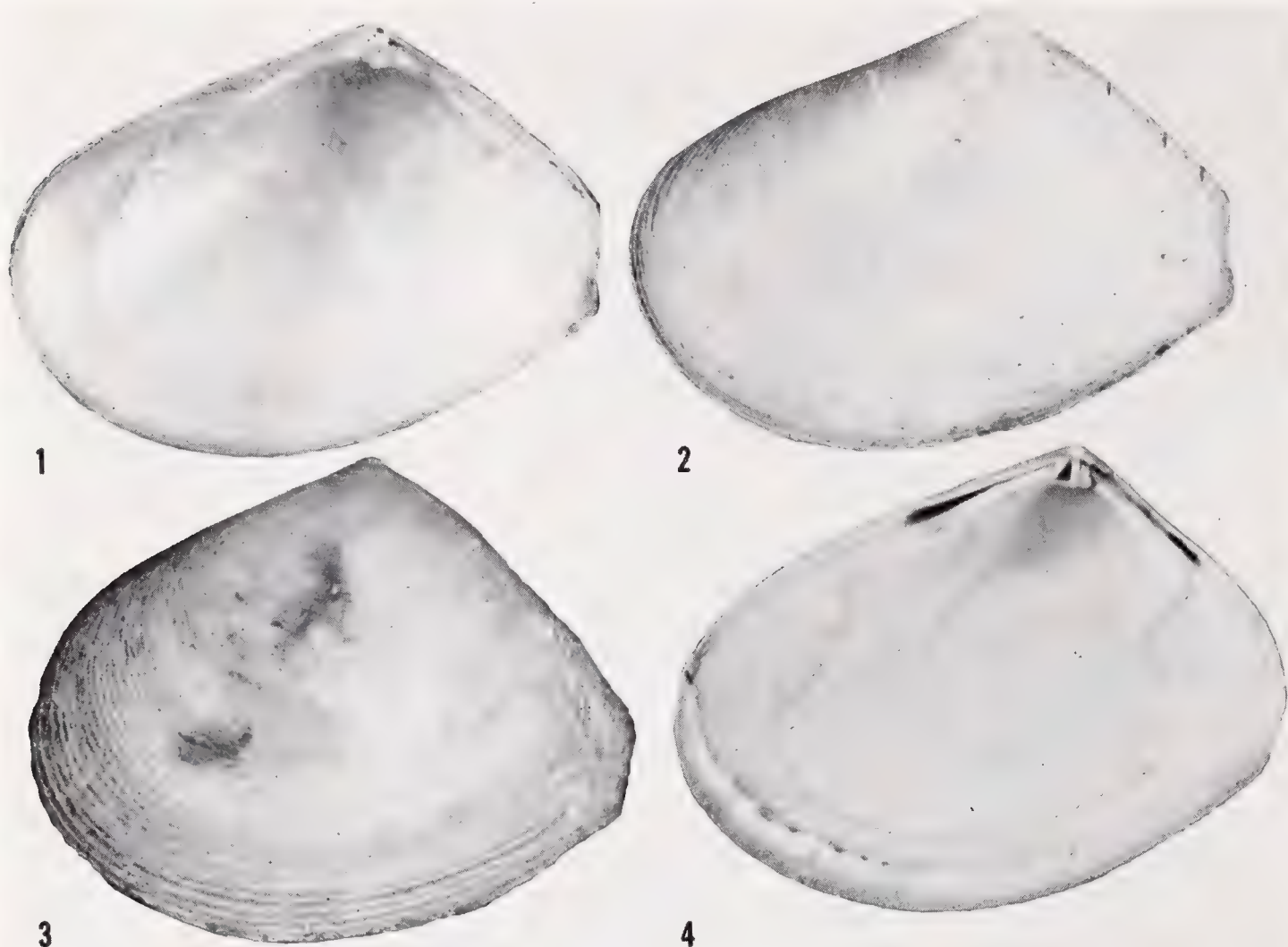


Plate 141. Figs. 1-2. *Tellina aequistriata* Say. Fig. 1. Internal view of the right valve. Fig. 2. External view of the right valve, Red Fish Pass, Captiva, Florida, MCZ 236307 (about 5x) [L=15.5 mm.]. Figs. 3-4. *Tellina alerta* Boss. Fig. 3. Internal view of the right valve of the paratype (about 9x) [L=8.3 mm.]. Fig. 4. External view of the left valve of the holotype, 32°45' S; 50°39' W, BMNH (about 9x) [L=8 mm.].

Heretofore, *Tellina aequistriata* Say and *T. lintea* Conrad have been maintained as separate entities but there are no morphological differences which can distinctly separate *aequistriata* into two species. Dall (1900b) noted that equal sized specimens were not divisible into separate species but he maintained that a difference of proportions was evident in adults. The differences of proportions in *aequistriata* are amply exhibited in any sizable sample from a population.

The near allies, *Tellina martinicensis* and *T. juttingae* are distinguished from *T. aequistriata* by the short confluence of the pallial line and the pallial sinus. *Tellina alerta* is the nearest relative of *T. aequistriata*, but in *alerta* the pallial sinus is widely separated from the anterior adductor muscle scar and the periostracum is dull red-brown. In the Eastern Pacific, the analog of *T. aequistriata* is *T. reclusa* Dall, which may be distinguished by its shorter more trigonal shape and its rasplike sculpture.

According to Parker (1960, p. 323), *Tellina acquistriata* is characteristically a member of the sandy bottom community along the intermediate shelf in the Gulf of Mexico at depths from 12–35 fathoms.

Range. This species is found from off Beaufort, North Carolina south throughout the Bahama Islands, the Greater and Lesser Antilles to off Bahia, Brasil.

Specimens examined. NORTH CAROLINA: Beaufort; off Cape Hatteras, in 9–22 fathoms; Pivers Island (all USNM). SOUTH CAROLINA: Sullivan's Island (CM). FLORIDA: Lake Worth; off Miami; off Caesar's Creek Bank; off Pacific Reef; Key Largo; Sombrero Key; Looe Key (all MCZ); Key West; Charlotte Harbor; Sarasota; Cedar Keys (all USNM); Destin; Pensacola (both MCZ). ALABAMA: Fort Morgan (MCZ). MISSISSIPPI: Horn Island (ANSP). TEXAS: Pass Cabello. MEXICO: Veracruz; Yucatan (both MCZ). GUATEMALA: Puerto Barrios (ANSP). BAHAMA ISLANDS: Little Abaco (MCZ); off North Bimini Island, in 20 fathoms (USNM); New Providence (MCZ); off Green Cay, in 9 fathoms (USNM). CUBA: *Barrera* station 211, Cape Cajon; *Barrera* station 209, Santa Rosa, in 3–6 fathoms; *Barrera* station 200, Santa Lucia, in 2–4 fathoms; *Barrera* station 204, Cayo Arenas, in 2 fathoms; *Barrera* station 208, Bahía Honda, in 1–12 fathoms; *Barrera* station 202, Cabanas Harbor, in 25 fathoms (all USNM); Matanzas Bay; Rio Arimas (both MCZ); off Isle of Pines, in 3 fathoms (USNM). JAMAICA: Montego Bay (USNM). HISPANIOLA. HAITI: Jerémie (USNM). PUERTO RICO: off Mayagüez, in 30 fathoms (USNM); off Enrique Reef, La Parguera, in 30–75 feet (IMPBR). VIRGIN ISLANDS: Charlotte Amalie, St. Thomas, in 30 feet (ANSP). LESSER ANTILLES: English Harbour, Antigua, in 7 fathoms (USNM); $\frac{3}{4}$ mile S of Fort St. Louis, Martinique (MCZ); Carlisle Bay, Barbados, in 6–12 fathoms (USNM); 2 miles S of Fort George, Scarborough, Tobago, in 36 fathoms (MCZ). CARIBBEAN ISLANDS: off the Stack, Georgetown, Grand Cayman Island, in 8 fathoms (ANSP). BRASIL: *Albatross I* station 2758, 34 miles SE of Natal ($06^{\circ}59' S$; $34^{\circ}47' W$), in 20 fathoms (USNM); off Bahia ($11^{\circ}49' S$; $37^{\circ}27' W$), in 12 fathoms (MCZ).

***Tellina (Merisca) alerta* Boss**

Plate 139, fig. 3; Plate 141, figs. 3–4

Quadrans linteus 'Conrad' Richards and Craig, 1963, Proc. Acad. Nat. Sci. Philadelphia, **115**: 135, pl. 1, figs. 8, 8, *non* Conrad 1837.

Tellina (Merisca) alerta Boss 1964, Occ. Pap. Dept. Mollusks, Harvard University, **2**: 309, pl. 55, figs. 1–2 (about 15 miles SE of Rio Grande do Sul, Brasil, in 48 fathoms ($32^{\circ}45' S$; $50^{\circ}39' W$); holotype, BMNH, no. 79.10.15.171.2).

Description. Shell extending to 8.2 mm. (about $5/6$ inch) in length and to 6.5 mm. (about $1/4$ inch) in height, elongate-subtrigonal, subsolid to thin, a little tumid with the left valve more convex and with a sharp flexure to the right posteriorly. Umbos central and pointed. Anterior margin smoothly rounded; ventral margin gently convex and rising in a concave basal arcuation posteriorly; anterior dorsal margin straight and gently inclined; posterior margin short, parallel with the dorso-ventral axis and forming a blunt truncation. Sculpture consisting of regularly spaced, raised lamellae (about 10–12 per millimeter) separated by sulci. Ligament light brown and slightly protuberant. Calcareous portion of the ligament poorly developed. In the left valve, the cardinal complex consists of an anterior subdeltoid tooth with subequal lobes and of a posterior extremely

elongate laminate tooth; distal anterior and posterior lateral teeth present, protruding and weak. In the right valve, the cardinal complex consists of a posterior thickened bifid tooth with subequal lobes and of an anterior subdeltoid laminate tooth; distal anterior and posterior lateral teeth present, elongate, strong upcurled and socketed. Adductor muscle scars well impressed. Anterior adductor scar elongate, pointed above and rounded below; posterior adductor scar subquadrate. Pallial sinus equal in opposite valves, rising gently behind, widely separated from the anterior adductor scar and forming a short confluence posteriorly. Periostracum dull reddish-brown, the external surface of the valves eroded in the umbonal region and the remainder a dull white.

length	height	width	
8.3 mm.	6.5 mm.	3.0 mm.	Paratype of <i>alerta</i>
8.0	6.0	2.8	Holotype of <i>alerta</i>

Remarks. *Tellina alerta* is most closely allied to *Tellina aequistriata*. The shape of the shell, the concentric sculpture and the configuration of the lateral teeth of the right valve serve to indicate the close relationship between these species. The pallial sinus is the most important character used to distinguish the species. In *aequistriata*, the sinus falls to and is confluent with the pallial line at or very near the base of the anterior adductor muscle scar while in *alerta* it is widely separated from the anterior adductor scar and the confluence of the sinus and the pallial line is short. *Tellina alerta* possesses a dark periostracum which differs from the white periostracum of *aequistriata*, and the lateral compression of the valves appears to be greater in *alerta*.

Range and specimens examined. This species is known from the type locality and from off Uruguay (34°47' S; 52°47' W) in 54.9 meters as figured by Richards and Craig (1963).

Subgenus *Acorylus* Olsson and Harbison

Acorylus Olsson and Harbison 1953, Acad. Nat. Sci., Philadelphia, Monograph 8, p. 128 (type species, *Tellina suberis* Dall 1900, original designation).

Description. Shell small, solid, obliquely subovate, with a right posterior flexure. Hinge line strong and heavy. Two strong lateral teeth in the right valve, equidistant from the cardinal complex and socketed. No true lateral teeth in the left valve. Pallial sinus large, reaching to the anterior adductor muscle scar and extensively confluent with the pallial line.

Acorylus is employed herein as described by Olsson and Harbison (1953). *Morella* with *Tellina donacina* Linnaeus as type is closely allied but differs in the increased strength of its concentric sculpture and the protuberant nature of the right lateral dentition. *Cadella*, a genus of Dall, Bartsch, and Rehder, with the Indo-Pacific *Tellina lechiogramma* Melville as type, is also close to *Acorylus*, but *Cadella* has a stronger sculpture and the confluence of the pallial line and the pallial sinus is not extensive.

Acorylus is monotypic in the recent fauna of the Western Atlantic.

Tellina (*Acorylus*) *gouldii* Hanley

Plate 139, fig. 4; Plate 142, fig. 4

Tellina cuneata d'Orbigny 1842 [in] Sagra, Hist. L'Ile Cuba, Atlas, pl. 26, figs. 21-23; 1845, Spanish Text, 2(5): 306 (Cuba y a las Floridas); 1853, French Text, Mollusques, 2: 256 [type locality, here restricted, Habana, Cuba; holotype, BMNH, no. 54.10.4.5.2], non Spengler 1798.

Tellina gouldii Hanley 1846 [in] Sowerby, Thesaurus Conchylorum, 1: 272, pl. 56, fig. 26 (West Indies) [type locality, here restricted, Habana, Cuba; holotype, BMNH], *non* Carpenter 1864.

Tellina (*Moera*) *gouldii* Hanley. H. and A. Adams 1856, Genera Recent Mollusca, 2: 396.

Tellina (*Acorylus*) *gouldii* Hanley. Olsson and Harbison 1953, Acad. Nat. Sci., Philadelphia, Monograph 8, p. 128.

Tellina (*Moerella*) *cuneata* d'Orbigny. Abbott 1958, Acad. Nat. Sci., Philadelphia, Monograph 11, p. 134, pl. 5 j and k, map 8.

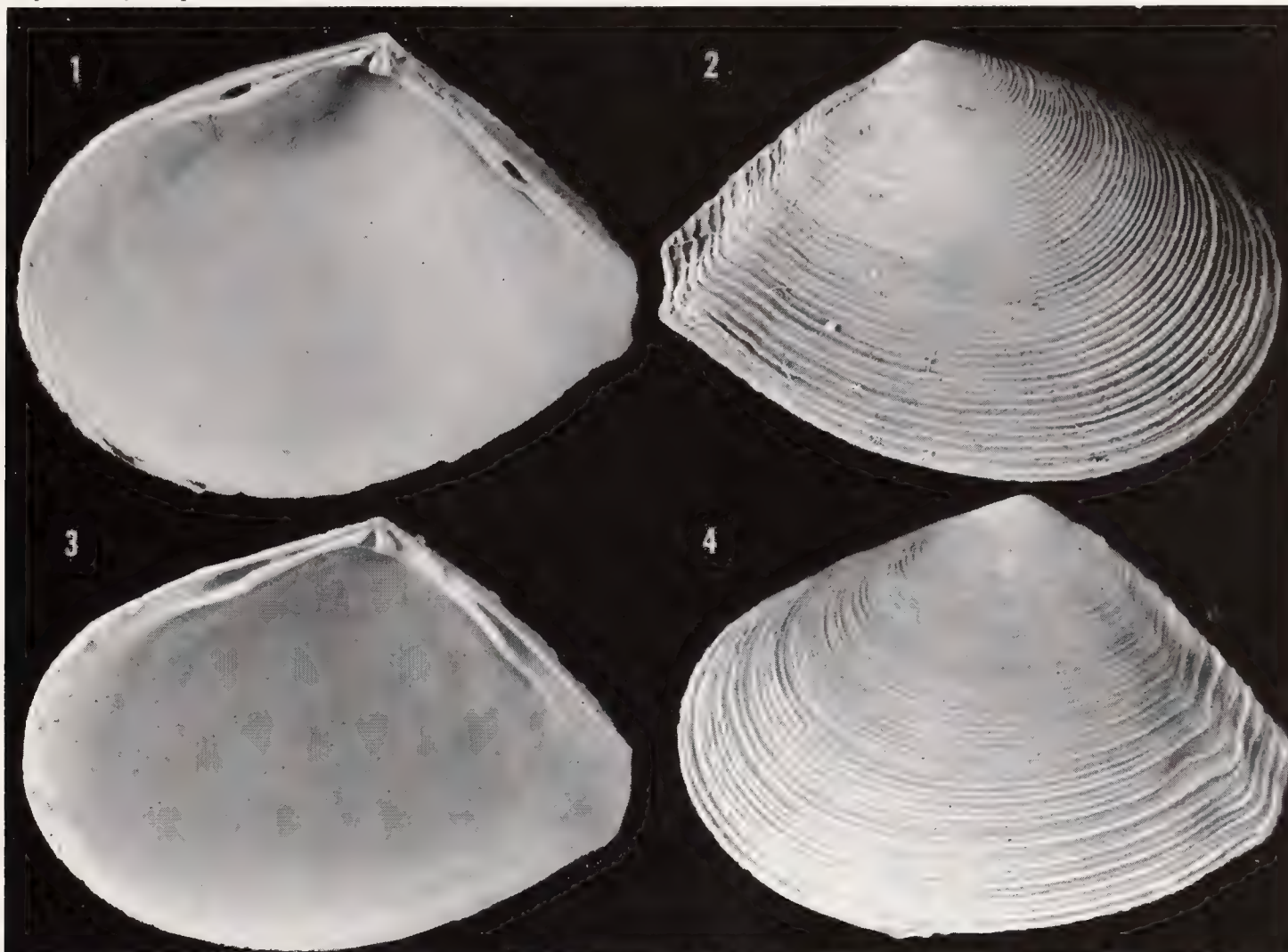


Plate 142. Figs. 1-2. *Tellina guadaloupensis* d'Orbigny [= *Tellina aequistriata* Say]. Fig. 1. Internal view of the right valve of the holotype. Fig. 2. External view of the left valve of the holotype, Guadeloupe, West Indies, CMNH (about 7x) [L=9.5 mm.]. Fig. 3. *Tellina tumida* Sowerby [= *Tellina aequistriata* Say], external view of the left valve of the holotype, Jamaica, BMNH (about 9x) [L=8.7 mm.]. Fig. 4. *Tellina gouldii* Hanley, internal view of the right valve, Bermuda, MCZ 243073 (about 8x) [L=9.5 mm.].

Description. Shell extending to 10.3 mm. (about $\frac{3}{8}$ inch) in length and to 7.8 mm. (about $\frac{1}{4}$ inch) in height, solid, heavy, obliquely subovate and with a very slight flexure to the right posteriorly. Umbos posterior to the middle, somewhat elevated and rounded. Anterior margin narrowly rounded; ventral margin convex and gently rising posteriorly; anterior dorsal margin long, straight and steeply sloping; posterior dorsal margin short and steep; posterior margin short and forming a truncation. Sculpture consisting of weak concentric lirations; obsolete radial sculpture sometimes evident. Ligament light golden-brown or yellow, not prominent and deeply set. In the left valve, the cardinal complex consists of an anterior small bifid tooth with subequal lobes and of a posterior thin laminate tooth; lateral teeth obsolete. In the right valve, the cardinal complex consists of a posterior deltoid bifid tooth with subequal lobes and of an anterior thin laminate tooth; lateral teeth equidistant from the cardinal complex, strong and socketed. Adductor muscle scars fairly well impressed. Anterior adductor lunate; posterior adductor large and

ovate. Pallial sinus rising abruptly, descending arcuately and touching the anterior adductor scar; confluence nearly entire. Shell white internally and externally; rarely iridescent.

length	height	width	
8.7 mm.	6.7 mm.	3.3 mm.	Holotype of <i>gouldii</i> Hanley
7.2	5.5	3.0	Holotype of <i>cuneata</i> d'Orb.
10.3	7.2	4.2	Bailey's Bay, Bermuda
9.2	7.8	4.1	Long Island, Bahamas
4.7	3.6	1.7	Grand Cayman Island

Remarks. This is a distinctive species whose small size and characteristic shape serve to distinguish it from other *Tellina*. The ancestors of *gouldii* are well represented in the Tertiary of North America and the Caribbean. The immediate predecessor to *gouldii* is *suberis* Dall from the Pliocene of Caloosahatchie, Florida. The species *gouldii* stands rather alone in its distant relationship to the other *Tellina* in the Western Atlantic and for that reason the subgeneric position given it by Olsson and Harbison is adopted.

In shape, *gouldii* might be confused with *Tellina candeana* d'Orbigny, but the latter may be immediately identified by its scissulate sculpture. Also, *gouldii* may be confused with *Semele nuculoides* Conrad, but the latter is distinguished by its internal ligament, its distinct escutcheon and its free pallial sinus.

Tellina gouldii prefers a sandy substrate within an association of sea grass in shallow water. Abbott (1958) has remarked that this species at Grand Cayman was found at depths between 6 and 25 feet in lagoons facing the open sea.

Range. From Bermuda, the Bahamas, Palm Beach, Florida in the north, this species extends through the Greater Antilles and Lesser Antilles to the north coast of South America.

Specimens examined. FLORIDA: off Palm Beach, in 100–130 fathoms (MCZ); off South Inlet, Lake Worth, in 7 fathoms (ANSP); off Miami, in 8–30 fathoms; off Fowey Light, in 25–38 fathoms; off Gov't Cut, in 5–35 fathoms; off Bear's Cut, in 18–20 fathoms; off Ajax Reef, in 4–40 fathoms; off Turtle Harbor, in 10 fathoms; Little Duck Key; off Conch Key, in 1–5 feet (all USNM); Tea Table Key (ANSP); Newfound Harbor Key; Key West; Garden Key, Tortugas (all USNM). MEXICO: *Albatross I* station 2365, 46 miles N of Cabo Catoche, Yucatan ($22^{\circ}18' N$; $87^{\circ}04' W$), in 24 fathoms (USNM). BERMUDA: Castle Roads, Castle Harbor, in 4–5 fathoms; North Rock, 11 miles N of Hamilton, in 4 fathoms; Bailey's Bay, in 8 feet (all MCZ); Casper's Island (USNM); Shelly Bay (ANSP; MCZ). BAHAMA ISLANDS: off Gun Cay, in 9 fathoms (USNM); Dick's Point, Nassau, New Providence (MCZ); Mintie Bar, South Bight, Andros (USNM); Little San Salvador; Orange Creek, Cat Island; Simms, Long Island; Matthew Town, Great Inagua (all MCZ). CUBA: *Barrera* station 211, Cape Cajon; *Barrera* station 208, Bahia Honda, in 1–12 fathoms; *Barrera* station 206, off Arroyos; *Barrera* station 202, Cabanas Harbor, in 25 fathoms; Habana; *Barrera* station 201, Cayo Levisa (all USNM); Pueblo Nuevo, Matanzas; *Atlantis* station 2999, Bahia de Matanzas ($23^{\circ}10' N$; $81^{\circ}29' W$), in 145–280 fathoms; Guarda la Vaca. Banes (all MCZ). HISPANIOLA. HAITI: Jerémie (USNM). VIRGIN ISLANDS: 1 mile E of East Point, Anegada Island, in 3–6 feet (ANSP); White Bay, Guana Island (MCZ); Judith's Fang, St. Croix (IMPBR). LESSER ANTILLES: Marigot Harbor, St. Lucia (MCZ); Carlisle Bay, Barbados, in 6–12 fathoms (USNM). CARIBBEAN ISLANDS: off Bowse Bluff and West Beach, Grand Cayman (both MCZ); SE of Swan Island, in 5 fathoms (MCZ). VENEZUELA: off Punta de Piedras, Isla de Margarita (ANSP).

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TELLINIDAE

VOL. 4, NO. 46

THE SUBFAMILY TELLININAE IN THE WESTERN ATLANTIC THE GENERA TELLINA (PART II) AND TELLIDORA¹

BY

KENNETH J. BOSS

Subgenus *Eurytellina* Fischer

Peronaeoderma 'Poli' Stoliczka 1870, Cretaceous Fauna of Southern India, 3: 116 (type species, *Tellina punicea* Born 1778, original designation), *non* Poli 1795, *nec* Mörch 1853.

Eurytellina Fischer 1887, Manuel de Conchyliologie, p. 1147 (type species, *Tellina punicea* Born 1778, monotypy).

Tellinota Iredale 1936, Rec. Aust. Mus., 19(5): 281 (type species, *Tellinota roseola* Iredale 1936, original designation).

Description. Shell elongate-elliptical to subtrigonal, somewhat compressed and slightly inequilateral; posterior flexure to the right, weak, obsolete or absent; surface sculpture rather poorly developed; ligament posterior, more or less protuberant, and strong; lateral teeth of the left valve poorly developed with a weak, tubercle-like proximal anterior tooth and an obsolete distal posterior lateral tooth; in the right valve, the distal posterior tooth is often well developed and the proximal anterior is generally well developed and strong; pallial sinus rather flattened dorsally and extending far anteriorly, near to or contiguous with the anterior adductor; confluence of the pallial sinus with the pallial line extensive. Anterior internal rib extends from the umbonal region to the anterior adductor scar and is strong, especially in the left valve.

The group of *Eurytellina* forms a natural assemblage of species characterized by the right lateral dentition, the more or less elongate elliptical shape of the shell, the compression of the valves, the strength of the internal radial rib and the relatively smooth superficial sculpture on the anterior slope and disc of each valve. The group appears to be most highly developed within the Western Atlantic and Eastern Pacific regions and constitutes a large element of the fauna. It is, furthermore, represented in the Indo-Pacific region by such species as *Tellina albinella* Lamarck of South Australia.

In the Western Atlantic, *Eurytellina* is more or less restricted to the shallow subtropical and tropical seas although a single species extends north to Cape Hatteras. The central area of concentration of species is the Caribbean. Three species are found in

¹ *Correction.* In Johnsonia no. 45 on pp. 268 and 271, Plates 141 and 142 are reversed. The plate caption on p. 268 applies to the plate on p. 271 and the plate caption on p. 271 applies to the plate on p. 268.

the Brazilian fauna but none of these is endemic. In the Eastern Pacific, the group is represented by more species, which have developed since the appearance of the subgenus in the Oligocene and Lower Miocene of North America.

KEY TO THE SPECIES OF THE SUBGENUS *EURYTELLINA*
IN THE WESTERN ATLANTIC

1. Posterior dorsal slope of the right valve with differentiated strong concentric sculpture 2
Posterior dorsal slope sculpture on the right valve not differentiated, similar to the sculpture on the central disc 3
2. Shell with an orange-apricot colored periostracum; adult size larger than 20 mm. *nitens*
Shell white to pellucid; very small in size (smaller than 15 mm. in adult) with a sharp posterior ridge in the right valve: left valve broadly tumid and convex *vespuciana*
3. Shell with numerous colored radial rays extending from the umbonal area to the periphery *guldinigi*
Shell unrayed or with one or two radial streaks extending anteriorly and posteriorly from the umbo but not extending to the periphery . . . 4
4. Shell sharply flexed to the right posteriorly; left valve broadly convex *lineata*
Shell not flexed or only very weakly flexed to the right posteriorly . . . 5
5. Shell bright red or purple; pallial sinus usually touching the anterior adductor muscle scar *punicea*
Shell not bright red or purple; pallial sinus usually free from the anterior adductor muscle scar 6
6. Shell high and subtrigonal in shape 7
Shell elongate-subtrigonal in shape 8
7. Shell with regular widely spaced incised sulci *angulosa*
Shell with sulci poorly incised and irregular *trinitatis*
8. Shell white or suffused with yellow or pink internally; lateral surface of anterior dorsal margin narrow; left valve weakly convex . . . *alternata*
Shell pink; lateral surface of anterior dorsal margin wide; left valve flattened on the disc *tayloriana*

***Tellina (Eurytellina) punicea* Born**

Plate 143, fig. 2; Plate 144, fig. 2; Plate 150, fig. 3

Tellina punicea Born 1778, Index Museum Caesarum Vindobinensis, p. 22; 1780, Index Mus. Caes. Vind., p. 33, pl. 2, fig. 8 (Patria ignota) [type locality, here restricted, Guayaguayare Beach, Trinidad; types not seen].

Tellina punicea Born. d'Orbigny 1853 [in] Sagra, Hist. L'Ile Cuba, Mollusques, 2: 298 (*pars*).

Tellina (Peronaeoderma) punicea Born. H. and A. Adams 1856, Genera Recent Mollusca, 2: 396.

Tellina (Eurytellina) punicea Born. Fischer 1887, Manuel de Conchyliologie, p. 1147.

Tellina (Eurytellina) angulosa 'Gmelin' Gardner 1928, United States Geol. Survey, Prof. Papers 142-e, p. 193, non Gmelin 1791.

Tellina (Eurytellina) punicea Born. Warmke and Abbott 1962, Caribbean Seashells, p. 195, pls. 4g and 40d.

Description. Shell extending to 45 mm. (about $1\frac{3}{4}$ inches) in length and to 28 mm. (about 1 inch) in height, elongate, nearly equilateral, moderately inflated, with the right

valve more convex and with an extremely weak posterior flexure to the right. Umbos just posterior to the middle, rounded, and rather inconspicuous. Anterior margin broadly and smoothly rounded; ventral margin straight or slightly convex, rising gently posteriorly; anterior and posterior dorsal margins usually subequal in length and gently sloping; posterior margin short, straight or slightly convex, giving a somewhat truncated appearance to the outline of the shell. Sculpture consisting of weakly incised concentric sulci separated by broad bands; these concentric bands are nearly equal in breadth in opposite valves. Ligament dark brown and somewhat sunken in a broad but shallow escutcheon; lunule narrow, shallow and long. Calcareous element of the ligament subtended by a rather strongly developed nymphal callosity in the right valve. Hinge line moderately developed. In the left valve, the cardinal complex consists of an interior thin, bifid tooth with subequal lobes and of a posterior, widely divergent, thin, laminate tooth; proximally anterior to the cardinal complex is a well developed but small lateral tooth. In the right valve, the cardinal complex consists of a posterior strong, skewed, deltoid, bifid tooth with the posterior lobe the larger and of an anterior strong, thickened, subdeltoid, laminate tooth; anterior lateral tooth well developed and proximal to the laminate cardinal tooth; posterior lateral tooth distal to the cardinal complex, strong and well developed. A rib extends from the umbonal region to the anterior adductor muscle. Muscle scars well impressed. Anterior adductor scar a little narrower and longer but not much higher than the posterior adductor scar. Pallial sinus equal in both valves, flattened

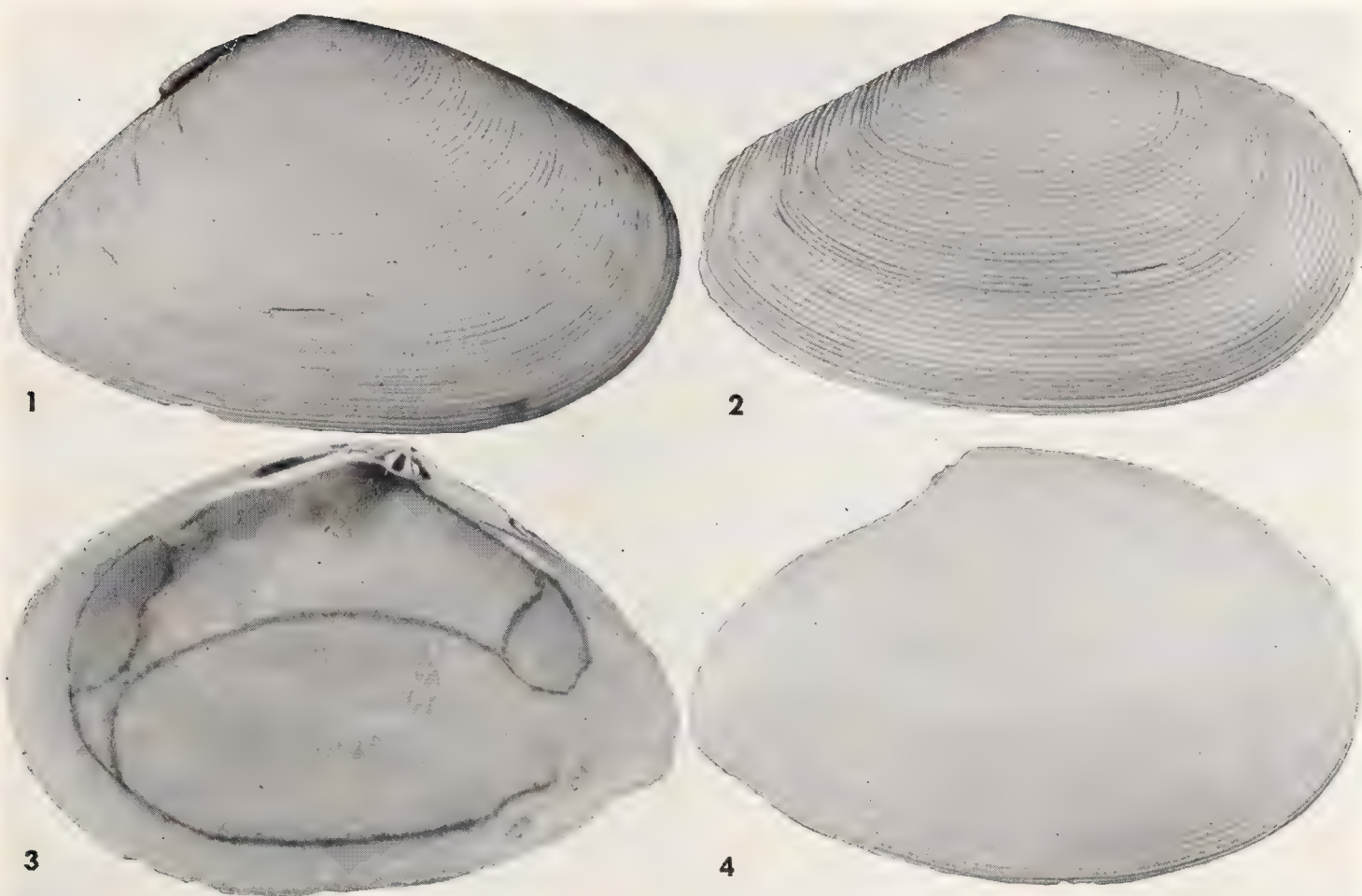


Plate 143. Fig. 1. *Tellina angulosa* Gmelin, external view of the right valve, St. Croix, Virgin Islands, MCZ 236382 (about 1.6x) [L=40 mm.]. Fig. 2. *Tellina punicea* Born, external view of the right valve, Punta Guanajibo, Puerto Rico, MCZ 236395 (about 2.4x) [L=31 mm.]. Figs. 3-4. *Tellina lineata* Turton. Fig. 3. Internal view of the right valve (about 2.5x) [L=30 mm.]. Fig. 4. External view of the right valve, Marco, Florida, MCZ 166044 (about 3.7x) [L=21 mm.].

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above and extending to and most often coalescing with the anterior adductor scar. The pallial sinus falls abruptly and straight to the pallial line and is confluent with it for most of its length. Externally, the shell is alternately and irregularly banded with white and dark red or purple. Internally the shining surface is generally a deep red or purple with a white periphery and with some suffusion of white especially in the region of the anterior rib and umbonal cavity.

length	height	width	
44.5 mm.	27.5 mm.	11.5 mm.	Gulf of Paria, Trinidad
42.5	27.0	10.5	Waunta Haulover, Nicaragua
40.0	25.0	9.2	Belize, British Honduras
38.9	24.6	10.3	Waunta Haulover, Nicaragua
38.5	22.5	8.5	Punta Guanajibo, Puerto Rico
27.4	16.6	5.3	Cartagena, Colombia
23.0	17.0	4.5	Puerto Plata, Santo Domingo
17.2	10.8	3.3	Cartagena, Colombia

Remarks. A great deal of confusion has reigned in the problem of recognizing this species. The name itself was originally introduced by Born in his Index in the 1778 edition; at that time no figure or locality was given. The description makes a considerable point of the coloration of the shell as well as the concentric striations and the growth lines. In 1780, a plate constituting the type figure accompanied the text, but unfortunately a view of the internal surface of either valve is not given; however, the shape of the shell, specifically its outline, as well as the external sculpture give a good representation of what today is considered *punicea*. A further difficulty lies in the fact that no type locality was given and subsequent workers, deciding that the species was West Indian, were not wont to restrict the locality. Since the species is very closely allied to *Tellina simulans* Adams of the Eastern Pacific, the difficulties encountered in the discussion of these species have been considerable.

Coloration is one of the major keys for recognizing *Tellina punicea*; indeed, Born's descriptive 'dunkel-rot' succinctly identifies most specimens. However, individuals in any population show considerable variation in degrees of purple or redness. As a matter of fact, a cline exists through the north-south range of the species where the most intensely red individuals are to be found in the Caribbean and where the proportions of deep redness decreases towards the south in Brasil. Another characteristic, employed to separate this species from others closely related to it or confused with it, is the fact that the pallial sinus extends to, touches, and even coalesces with the anterior adductor muscle scar. But even this character is not infallible, since in some lots, in one valve of a specimen, the sinus may not quite touch the anterior muscle scar but be connected to it by means of a short linear scar. Nevertheless, there can be no doubt about *punicea* when complete specimens taken in a series are examined. The coalescence of the pallial sinus with the muscle scar, the elongate shape of the shell, the irregularly concentric sculpture, the concentric banding of coloration of the interior best characterize the species.

Allometric differences also occur. Younger specimens, in general, have a slightly different proportion than the adult or larger specimens. The shells are lower and appear more elongate; the posterior rise or arcuation of the ventral margin is more noticeable and the posterior dorsal margin tends to be markedly convex. In addition to the previously mentioned cline in coloration, some clinal variation occurs with respect to the

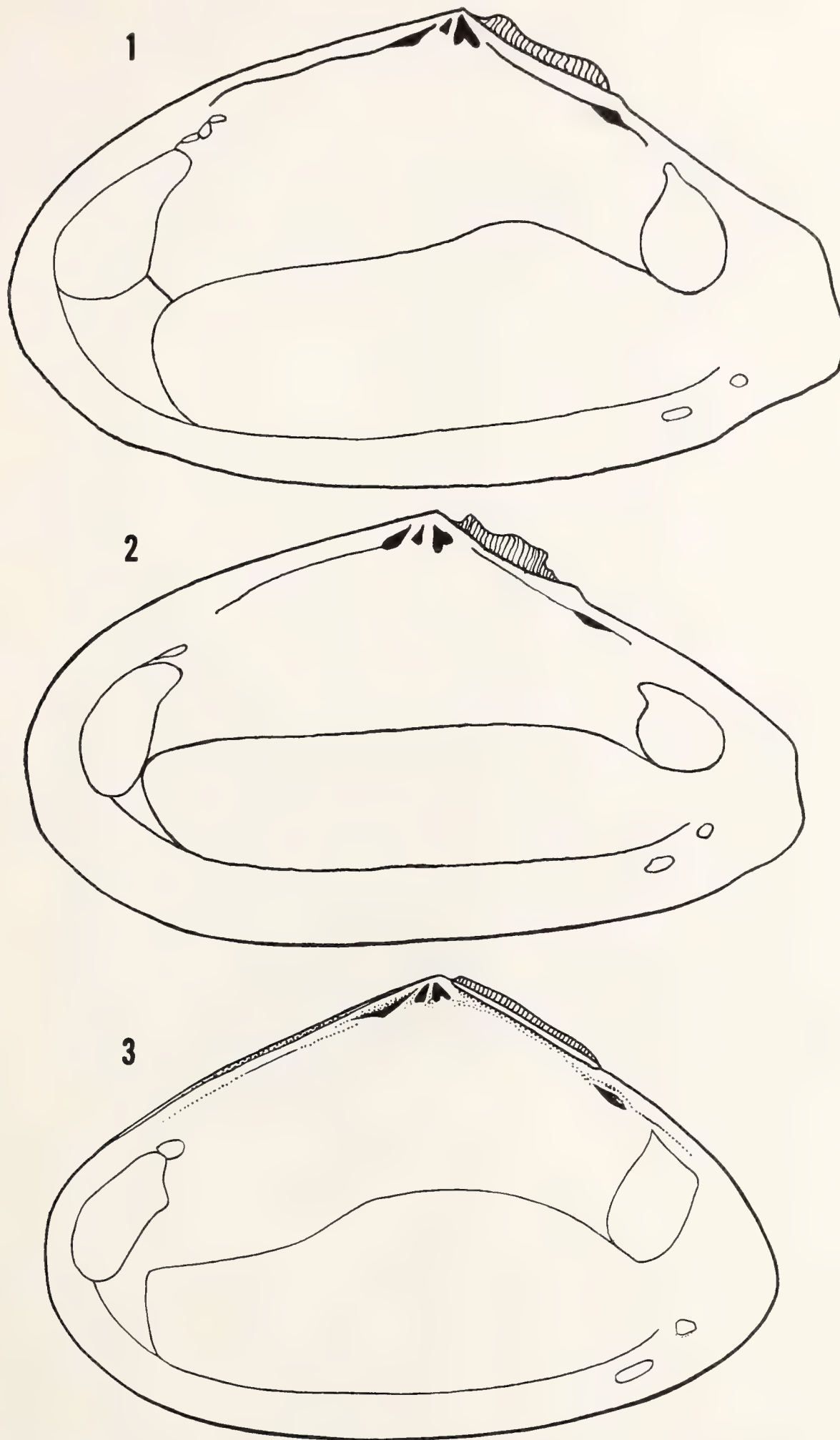


Plate 144. Figs. 1-3. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina alternata* Say (about 1.9x) [L=65 mm.]. Fig. 2. *Tellina punicea* Born (about 2.9x) [L=40 mm.]. Fig. 3. *Tellina angulosa* Gmelin (about 2.6x) [L=40 mm.].

thickness and the convexity of the shell. Most specimens from the Caribbean, or northernmost extent of the range, tend to possess a thinner shell which is quite compressed while in the southern portion of the range, more specimens have thicker shells which exhibit an increased convexity.

According to Hertlein and Strong (1949) and Olsson (1961) *Tellina punicea* Born is closely allied to *Tellina simulans* Adams of the Eastern Pacific fauna. The former authors who have had the opportunity of comparing a series of both species have concluded that: "The west coast shells are more pointed posteriorly, there is a low depressed area anterior to the posterior angulation on the right valve, and the concentric grooves along the posterior dorsal margin bend more acutely upward than those on the east coast shells." It is also probable that a species, *T. cibaoica*, described by Maury from the Lower Miocene of Santo Domingo represents an early precursor of this complex; it is treated under *Tellina angulosa*.

The species lives in relatively shallow, off-shore waters; it has been taken at 30 feet. Although little information is available as to its substrate preference, many samples have come from soft, black muddy bottoms.

Range. This species appears to be limited to the Caribbean Region and South America. It is found from British Honduras and Jamaica south through the Antilles and along the Caribbean coast of Central and South America and as far south as Estado de Santa Catarina, Brasil.

Specimens examined. BRITISH HONDURAS: Belize (USNM). NICARAGUA: Waunta Haulover (USNM; MCZ). COSTA RICA: Port Limon (ANSP; USNM). PANAMA: Bocas de Toro (ANSP); Lobobo Light, Chiriqui Lagoon; mouth of Rio Code del Norte; Fort Sherman, Devil's Beach; Colon (all USNM). JAMAICA: Lucea Harbour (USNM); White River Beach (MCZ); Black River; Great Pedro Bay; Kingston; Morant Key (all USNM). HISPANIOLA. HAITI: Port au Prince; Torbeck; Les Cayes; Saltrou (all USNM). SANTO DOMINGO: Manzanillo Bay (MCZ); Monte Cristi (ANSP; MCZ); Puerto Plata; Santa Barbara de Samana (both MCZ). PUERTO RICO: Mayaguez (IMBPR; MCZ); Punta Guanajibo (IMBPR; ANSP; MCZ); Cayos Trios, in 30 feet (IMBPR); Humacao Playa (MCZ); Bahia Bramadero (ANSP). VIRGIN ISLANDS: St. Thomas (USNM); St. Croix (ANSP). LESSER ANTILLES: Bridgetown, Barbados (USNM); 2 miles S of Scarborough, Tobago, in 36 fathoms; Trinidad side of the Gulf of Paria; Ortoire River, Mayaro; Manzanilla Beach, Trinidad; Guayaguayare Beach, Trinidad (all MCZ). COLOMBIA: Gulf of Uraba; Punta Brazules (both USNM); Cartagena (USNM; MCZ); Puerto Colombia (USNM). VENEZUELA: Lake Maracaibo; Beaches at Macuto, Maiquetia (both ANSP); La Guaira; 4.3 kilometers W of Barcelona (both USNM); Guante (ANSP); Cumaná (USNM); Cubagna Island (MCZ); Margarita Island (ANSP). SURINAM: Surinam (MCZ). BRASIL: Fernando de Noronha; Fortaleza, Ceara; Ilha de Itaparica, Bahia (all MCZ); Ilheus, Bahia (USNM); Vitoria, Espirito Santo (ANSP; MCZ); Carapebus, Espirito Santo; Praia Comprida; Mambucaba, Rio de Janeiro (all MCZ); Rio de Janeiro (ANSP); Ilha de São Sebastiao and Santos, São Paulo (both USNM); Praia Grande, Itanhaém, São Paulo (MCZ); São Francisco do Sul, Santa Catarina (USNM).

***Tellina (Eurytellina) trinitatis* Tomlin**

Plate 145, fig. 1-2; Plate 149, fig. 5

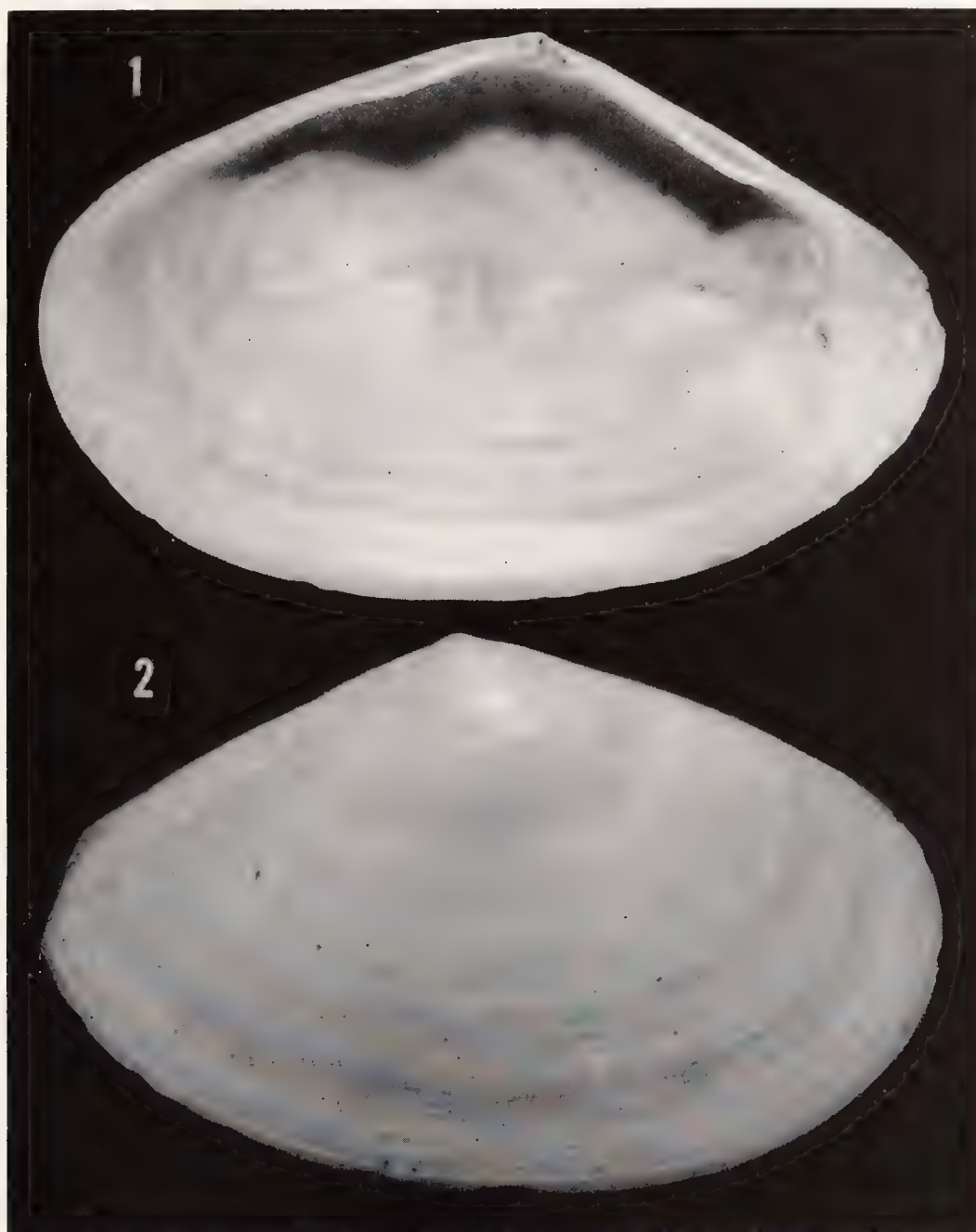
Eurytellina trinitatis Tomlin 1929, Jour. Conch., 18(11): 310 (Colón Harbour, Panamá) [Holotype, BMNH].

Plate 145. *Tellina trinitatis* Tomlin. Fig. 1. Internal view of the right valve, Payarde, Panamá, MCZ 258317 (about 2.8x) [L=37 mm.]. Fig. 2. External view of the right valve, Marco, Florida, MCZ 258316 (about 4.4x) [L=23 mm.].

Description. Shell extending to 38 mm. (about $1\frac{1}{2}$ inches) in length and to 25 mm. (about 1 inch) in height, elliptical-subtrigonal, equivalve, nearly equilateral, solid, moderately inflated, with both valves of a more or less equal convexity and with an obsolete posterior flexure to the right. Umbos central, but little elevated, not inflated, conspicuous, white in color, smooth and pointed. Anterior margin smoothly and somewhat narrowly rounded; ventral margin convex and rising gently posteriorly; anterior dorsal margin more or less straight, long and gently inclined; posterior dorsal margin straight and long; posterior margin very short and forming an oblique truncation. Sculpture consisting of weak, closely and irregularly spaced concentric bands; sulci poorly incised; weak radial lirations evident. Weak posterior ridge present in both valves. Ligament

brown, short, slightly protuberant, set in a lanceolate escutcheon; lunule obsolete. Calcareous portion of the ligament subtended by poorly developed nymphal callosities. Hinge line with strong lateral dentition in the right valve. In the left valve, the cardinal complex consists of an anterior thin bifid tooth with more or less equal lobes and of a thin elongate posterior laminate tooth; no true lateral dentition, but obsolete tubercles present along the hinge line anteriorly and posteriorly. In the right valve, the cardinal complex consists of a posterior, small, slightly thickened bifid tooth with subequal lobes and of an anterior small subdeltoid laminate tooth; anterior lateral tooth well developed, thin, elongate, slightly upcurled and subproximal to the cardinal complex; posterior lateral tooth distal to the cardinal complex, elongate and somewhat upcurled. Internal radial rib obsolete. Adductor muscle scars moderately impressed. Anterior adductor muscle scar irregularly sublunate; posterior adductor scar subquadrate. Pallial sinus hardly rising behind, slightly convex above, extending to, nearly coalescing with, but generally slightly free from the anterior adductor muscle scar, and then falling in a more or less straight short line to the pallial line. The pallial sinus is generally united to the anterior adductor muscle scar by a short straight interlinear scar. Color pink with whitened periphery, posterior slope and umbo; pink coloration more intense internally and often disposed in variable bands externally; in adults a concentrated radial streak of color parallels the posterior ridges externally.

length	height	width	
32.6 mm.	19.4 mm.	7.5 mm.	Holotype of <i>trinitatis</i> Tomlin
38.0	25.0	—	off Surinam
36.0	23.5	—	Guantanamo Bay, Oriente, Cuba
25.5	15.5	6.5	Coronie, Surinam
19.5	12.0	5.0	Coronie, Surinam

Remarks. This species is a poorly known member of the *Eurytellina* complex. In the Western Atlantic fauna, it is probably most closely related to *Tellina punicea* Born. *Tellina trinitatis* is not as intensely purple as is *punicea* and the pallial sinus of *trinitatis* is generally separated from the anterior adductor muscle scar. The short oblique posterior margin and the characteristically pointed umbo as well as the convexly rising ventral margin distinguish *trinitatis*. *Tellina angulosa* is also nearly allied but is much different in regard to its sculpture which is stronger and more widely spaced. Further, the right anterior lateral tooth of *trinitatis* is more distally removed from the cardinal complex than it is in either *angulosa* or *punicea*. In the Eastern Pacific, *Tellina prora* Hanley is the analog of *trinitatis*.

Range. This species has been found as far north as Marco, Florida and as far south as Arroyo de Pando, Canelones, Uruguay; however, both of these records may be questioned since the specimens were not complete. Certainly the central concentration of the range of *trinitatis* is the Caribbean Sea; it was taken in abundance in a soft black muddy substrate at 10 fathoms in the Gulf of Venezuela.

Specimens examined. FLORIDA: Marco (MCZ). CUBA: Guantanamo Bay, Oriente (MCZ). PANAMA: Payarde (MCZ, Olsson); Colón (type, BMNH); Fort Sherman, Devil's Beach, 5 miles N of Colón (USNM). VENEZUELA: Oregon station 5669, Gulf of Venezuela (MCZ). SURINAM: Coronie Strand (Leiden, Altena). URUGUAY: Arroyo de Pando, Canelones (USNM).

Tellina (Eurytellina) angulosa Gmelin

Plate 143, fig. 1; Plate 144, fig. 3; Plate 148, fig. 2

Tellina angulosa Gmelin 1791, Systema Naturae, Ed. 13, p. 3244 (ad insulas Americae) [type locality, here restricted, St. Croix, Virgin Islands; types not seen], *non* Röding 1798, *nec* Renier 1804.

Tellina striata Spengler 1798, Skrivter Naturhistorie Selskabet, Copenhagen, 4(2): 105 [type locality, here restricted, St. Croix, Virgin Islands; types, Zoological Museum, Copenhagen], *non* Costa 1829.

Tellina laeta Montagu 1804, Testacea Britannica, p. 57 (*pars*).

Tellina punicea 'Born' Lamarck 1818, Animaux s. Vertebres, 5: 525; d'Orbigny 1853 [in] Sagra, Hist. L'Ile Cuba, Mollusques, 2: 298 (*pars*).

Donax martinicensis Lamarck 1818, Animaux s. Vertebres, 5: 552 (Martinique); 1841, Delessert, pl. 6, fig. 15 [types, Museum d'Histoire Naturelle, Paris].

Tellinides rosacea King and Broderip 1832 (*teste* Hanley), Zool. Journ., 5: 19 (Santos, Brasil) [types not seen].

Tellina hanleyi 'Deshayes MS' H. and A. Adams 1856 (*teste* Dall), Genera Recent Mollusca, 2: 396, *non* Dunker 1853, *nec* Bertin 1878 (*nomen nudum*).

Tellina subradiata 'Schumacher' Arango 1880, Contrib. Fauna Mala., Cubana, p. 244 (*nomen nudum*).

Tellina (Eurytellina) angulosa Gmelin. Dall 1900, Proc. U.S. Nat. Mus., 23: 294.

Tellina (Arcopagia) angulosa Gmelin. McLean 1951, New York Acad. Sci., 17(1): 93.

Tellina (Eurytellina) punicea 'Born' Gardner 1928, United States Geol. Survey, Prof. Papers 142-e, p. 193, *non* Born 1778.

Description. Shell extending to 50 mm. (about 2 inches) in length and to 38 mm. (about 1½ inches) in height, subtrigonal, nearly equilateral, slightly inflated, with the left valve more convex and with usually a very slight flexure to the right posteriorly. Umbos only slightly posterior to the middle, little elevated, somewhat inconspicuous and often pointed. The anterior margin broadly and smoothly rounded; the ventral margin straight or somewhat convex with a slight postbasal arcuation; anterior dorsal margin gently sloping and short, usually straight, but sometimes convex; posterior dorsal margin rather long and moderately steep; posterior margin short, straight and producing a truncated appearance to the outline of the shell. Sculpture consisting of rather deeply incised concentric sulci separated by rather broad elevated bands; this concentric sculpture is unlike in opposite valves; in the left valve, the elevated bands are broader and the sulci fewer. A slight posterior ridge occurs on the right valve and a concomitant sulcus on the left. Ligament brown, protuberant, set in a narrow escutcheon and subtended by developed nymphal callosities. Hinge line moderately developed. In the left valve, the cardinal complex consists of an anterior, deltoid bifid tooth with subequal lobes and of a posterior, thin laminate tooth which is adpressed to the calcareous element of the ligament; proximally anterior to the bifid cardinal tooth is the small anterior lateral tooth; the distal posterior lateral is moderately well developed. In the right valve, the cardinal complex consists of a posterior, slightly skewed, bifid tooth with subequal lobes and of an anterior thickened laminate cardinal tooth; posterior lateral tooth well developed, strong, and distal; anterior lateral tooth well developed, but weaker than the posterior lateral and located next to the laminate cardinal tooth. A rib extends from the umbonal region to the anterior adductor muscle scar in the left valve. Adductor muscle scars well impressed. Pallial sinus equal in opposite valves, long, rising gently behind, forming a slightly pointed apex far below the umbo, extending almost to but separated and not contiguous with the anterior adductor scar, and falling at a slight angle to the pallial line with which it is extensively confluent. A small interlinear scar often extends between the pallial sinus and the anterior adductor scar. Externally the shell is predominantly

white and pink, shining and somewhat glabrous; localized concentrations of pink occur as rays extending from the umbo. There are usually three such radiations, one paralleling the posterior ridge, another in the posterior quarter of the disc and a third along the anterior slope, more or less parallel to the anterior dorsal margin. Tints of yellow or apricot may augment or replace the pink, and rarely specimens may be nearly pure white. Some specimens also have indications of concentric bandings of white and pink. Internally, the shell is polished and usually suffused with white. A peripheral band of white is most often present.

length	height	width	
50.0 mm.	38.0 mm.	—	Altona Lagoon, St. Croix, Virgin Islands
46.0	30.5	12.0	São Paulo, Brasil
40.0	26.0	9.5	Altona Lagoon, St. Croix, Virgin Islands
39.0	26.5	8.0	Boca Chica Key, Florida
37.5	22.5	7.5	Manguinhos, Ilha de Itaparica, Bahia, Brasil

Remarks. *Tellina angulosa* Gmelin has been variously interpreted by numerous workers; the type figure is in Chemnitz (Conch. Cab., 1st Ed., vol. 10, pl. 120, figs. 1654 and 1655). It may be most easily confused with *Tellina alternata* and some discussion of the important traits which characterize each species have been given (see *Remarks* under *T. alternata*). *Tellina angulosa* is typically subtrigonal, its height is higher in proportion to its length when compared with *T. alternata*. In addition, the orange-red rays which color the umbonal region of *angulosa* are distinctive. In the northernmost extension of its range, *angulosa* overlaps with the range of *alternata*. In certain areas of Florida, *angulosa* tends to possess a thicker and heavier shell; the shell may exhibit more elongate proportions, but usually the posterior dorsal slope maintains a typical convexity which is diagnostic. Since some lots from southern Florida are mixed or nearly impossible to distinguish, it is possible that hybridization is occurring; however, some different or peculiar ecological conditions may prevail in certain areas to which *angulosa* has become adapted.

Tellina punicea Born, which is almost completely Caribbean in its distribution, may also be confused with *T. angulosa*, but in the latter, the pallial sinus remains distinctly free from the anterior adductor muscle scar and the orange-red coloration of the shell never approaches the intense purple-red of *T. punicea*.

The fossil history of *Tellina angulosa* has its recognizable beginning in the Miocene. *Tellina roburina* Dall from the Oak Grove Sands in Florida is markedly similar to *angulosa*. Gardner (1928) records the presence of *T. roburina* in the Alum Bluff formation of the Middle Miocene; she mentions that the lateral teeth attain a greater strength and are somewhat farther removed from the cardinal complex than similar modern forms. Maury (1917) described *Tellina cibaoica* from the Lower Miocene of Santo Domingo which though comparable to the recent *Tellina punicea* Born, is by virtue of its subtrigonal shape quite similar to *angulosa*. In the Bowden formation of Jamaica, none of the *Eurytellina* bears a resemblance to *angulosa*.

Although *Tellina rubescens* Hanley of the Eastern Pacific has been considered an analog of *T. angulosa*, it is certainly quite dissimilar in regard to the pallial sinus which is coextensive with the anterior adductor muscle scar. *Tellina eburnea* Hanley (= *panamensis* Li; = *liliana* Hertlein and Strong) is comparable in shape, in outline, and in the

configuration of the pallial sinus; it differs from *angulosa* in its heavier valves and pure white coloration.

Range. This species is found as far north as the southeastern and southwestern coasts of Florida. It occurs along the Gulf and Caribbean coasts of the Yucatan Peninsula and throughout the Greater and Lesser Antilles south to Brasil and Uruguay.

Specimens examined. FLORIDA: Virginia Key (MCZ); Biscayne Bay (Bulloch; ANSP); Boca Chica Key (MCZ); East Cape Sable; Marco Beach and Marco River (all D. and N. Schmidt); Sarasota Bay (USNM). MEXICO: Isla del Carmen (MCZ). Campeche; Yucatan (both ANSP). BRITISH HONDURAS: Belize (USNM). GUATEMALA: Puerto Barrios (ANSP). PANAMA: Payarde (Olsson). CUBA: *Barrera* station 220, Havana; *Barrera* station 213, Varadero Beach; *Barrera* station 221, Cardenas, in 1–3 fathoms (all USNM); Icacos Peninsula, in 3–4 fathoms (ANSP). JAMAICA: Green Island Harbour, Hanover; Black River, St. Elizabeth (both USNM); Little Goat Island, Portland Bight (MCZ). HISPANIOLA. HAITI: Bizoton; Aquin (both USNM). SANTO DOMINGO: Monte Cristi (MCZ); Puerto Plata (USNM); Santa Barbara de Samana (USNM; MCZ). PUERTO RICO: Punta Guanajibo (ANSP; MCZ); Ponce; La Parquera (both MCZ); Las Croahas, Fajardo (ANSP). VIRGIN ISLANDS: Magen's Bay, St. Thomas (ANSP); St. John's (ANSP; MCZ); Altona Lagoon, St. Croix (MCZ). LESSER ANTILLES: Guadeloupe (ANSP; MCZ); Roseau, Dominica (ANSP); St. Lucia, in 10 fathoms (USNM; MCZ); Chaguaramas Bay, Trinidad (USNM); Guayaguayare Beach, Trinidad (MCZ). VENEZUELA: Cumana (USNM); Margarita Island (MCZ). BRASIL: Praia Grande and Manguinhos, Ilha de Itaparica, Bahia; Pedra Furada, Bahia (all MCZ); Ilha Grande, Federal District (USNM); Praia de Caraquatuba, São Paulo; São Paulo (both MCZ). URUGUAY: Arroyo de Pando, Canelones (MCZ).

***Tellina (Eurytellina) alternata* Say**

Plate 144, fig. 1; Plate 146, figs. 2–4

Tellina alternata Say 1822, Jour. Acad. Nat. Sci., Philadelphia, **2**: 275; 1833 (?) Conrad [*in*] Say, American Conchology, **7**: pl. 65, fig. 1 (inhabits the coast of Georgia and East Florida) [type locality, here restricted, Sea Island, Georgia; holotype apparently lost].

Tellina (Peronaeoderma) alternata Say. H. and A. Adams 1856, Genera Recent Mollusca, **2**: 396.

Tellina planulata Sowerby 1867 [*in*] Reeve, Conch. Icon., **17**, *Tellina*, pl. 33, fig. 186 (type locality unknown) [type locality, here restricted, Sea Island, Georgia; holotype, BMNH, no. 74.12.11.244].

Tellina (Eurytellina) alternata Say. Dall 1900, Trans. Wagner Free Inst. Sci., Philadelphia, **3**(5): 1029.

Description. Shell extending to 72 mm. (about $2\frac{3}{4}$ inches) in length and to 40 mm. (about $1\frac{1}{2}$ inches) in height, elongate-subtrigonal, slightly inequilateral, somewhat compressed with the left valve slightly more convex and with a gentle flexure to the right posteriorly. Umbos slightly posterior to the middle, scarcely elevated, small, and often pointed. Anterior margin smoothly and broadly rounded; ventral margin more or less straight and rising posteriorly in a gentle arcuation; anterior dorsal margin gently sloping, convex and rather long; posterior dorsal margin straight, not too steeply sloping and very long; posterior margin extremely short, straight, rarely perpendicular to the dorsoventral axis. In outline, the shell appears to be attenuate posteriorly with a slight but marked truncation. Sculpture consisting of incised concentric sulci separated by

broad bands. A discrepancy exists between the valves; the left valve has broader bands and less sulci. A posterior ridge occurs in the right valve and a poorly developed concomitant sulcus on the left valve. Ligament light brown to black, strong, protuberant, and set in an ill defined escutcheon. Calcareous portion of the ligament well developed and subtended by nymphal callosities. Hinge line moderately developed. In the left valve, the cardinal complex consists of an anterior somewhat strong, bifid cardinal tooth with equal lobes and of a posterior, thin, laminate tooth which is often broken or lost. Proximally anterior to the bifid cardinal tooth is a rather well developed, but small lateral tooth; the distal posterior lateral tooth is weakly developed or obsolete. In the right valve, the cardinal complex consists of a posterior skewed, moderately strong bifid tooth with the posterior lobe the larger and of an anterior, thickened laminate cardinal tooth; anterior lateral tooth small, thin, and located next to the laminate cardinal tooth; posterior lateral tooth distal and stronger. In both valves an internal rib extends from the umbo to the anterior adductor muscle scar. Adductor muscle scars usually well impressed. Pallial sinus equal in both valves, rising slightly to a high point far beneath the umbos and extending far anteriorly near to but not contiguous with the anterior adductor scar. Often a small linear scar connects the pallial sinus with the anterior adductor scar. The pallial sinus falls arcuately to the pallial line; confluence extensive. Externally, the shell is shining, glabrous, and nearly always white, often with slight suffusions of pink or yellow; a yellowish-brown periostracum may augment the superficial coloration. Internally, the base color is a polished white with suffusions of yellow and rarely pink or apricot.

length	height	width	
68.0 mm.	37.8 mm.	12.0 mm.	Holotype of <i>planulata</i> Sowerby
72.0	40.0	13.0	Amelia Island, Florida
55.0	29.5	9.5	Cocoa Beach, Florida
50.5	32.0	13.5	Biscayne Bay, Florida
49.0	28.0	11.0	Fort Myers Beach, Florida
44.5	25.5	9.5	Treasure Island, off Pasadena, Florida

Remarks. *Tellina alternata* is one of the largest and most common tellens of the Atlantic coast of North America. It appears to prefer the sandy substrates along the shelf region in depths from 10–70 fathoms. It is typically elongate, white and with some yellowish suffusions internally. Its similarity to a number of other species is remarkable. With *Tellina nitida* Lamarck of European waters, it may be confused because of the similarity in shape and coloration, but the lack of eurytellinid dentition in *nitida* as well as the absence of intercalated sculpture on the posterior slope of *alternata* serve sufficiently to distinguish each species. Records of *alternata* in European waters have, no doubt, been established upon its outward similarity to *nitida*.

Certain species in the Western Atlantic with which *alternata* may be confused include *T. tayloriana* and *T. angulosa*. *Tellina tayloriana* has been considered a synonym of *alternata* by some authors (Dall 1900a) but herein both species are recognized in accordance with the interpretation of Olsson and Harbison (1953). Traits which distinguish *tayloriana* and *alternata* are discussed elsewhere (see *Remarks* under *T. tayloriana*). Color is the simplest and, in this case, one of the most reliable characteristics employed to distinguish *tayloriana*, which is pink, and *alternata*, which is white or yellow-white. There appears to be a slight overlapping in the ranges of these species along the Gulf coast and no clear cut line separates the populations.

Tellina angulosa Gmelin replaces *T. alternata* in the Antillean and Caribbean Regions. In general, *alternata* is much more elongate than *angulosa* and, therefore, less subtrigonal. The sculptural pattern of *alternata* is dissimilar in opposite valves. The right valve has the concentric sculpture more crowded with the concentric band consequently narrowed; the left valve possesses proportionally fewer sulci and consequently the sculpture is less crowded with the concentric bands broader. The right valve has from four to nine more sulci per centimeter than the left. In contradistinction to this condition, *T. angulosa* possesses valves upon which the concentric sculpture is less dissimilar. This characteristic is best employed in conjunction with a discreet appraisal of shape and color. *Tellina angulosa* has a tendency to have an anterior and a posterior orange-red ray emanating from the umbonal region; the shell tends to be thinner and more translucent; the angle of declination of the posterior dorsal slope is steeper and the margin itself is more convex than *alternata*.

In the Eastern Pacific, the subgenus *Eurytellina* is considerably richer in species but no single species from this region may be recognized as an analog of *Tellina alternata*. In general outline, *T. laceridens* Hanley and *T. hertleini* Olsson approach *alternata* but the pallial sinus is confluent with the anterior adductor muscle scar in both of the former.

In the fossil record, *Tellina alternata* has been recorded in the Pleistocene of the Gulf States by Maury (1920), the Pliocene of Florida by Dall (1900b), Olsson and Harbison (1953), and in the Pliocene of the Carolinas by Tuomey and Holmes (1857). Mansfield (1932) has given also a record from the upper Miocene of Harver's Creek, Florida. From the Lower Miocene of Santo Domingo, Maury (1917) has described *Tellina riocanensis* which bears some resemblance to *alternata* and is a probable ancestor to the recent species.

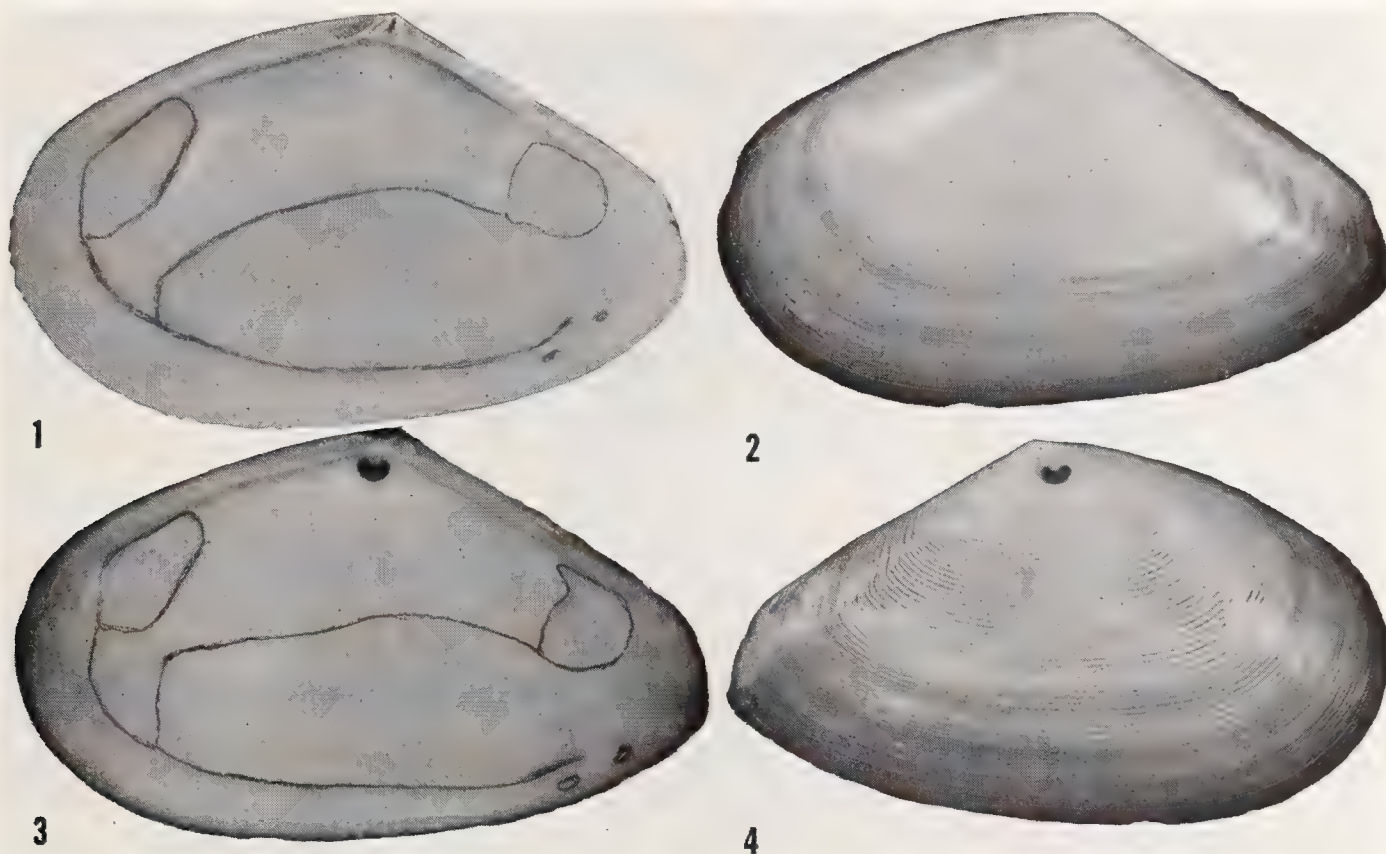


Plate 146. Fig. 1. *Tellina tayloriana* Sowerby, internal view of the right valve of the holotype, Mexico, BMNH (about 1.2x) [L=57.8 mm.]. Figs. 2-4. *Tellina planulata* Sowerby [= *Tellina alternata* Say]. Fig. 2. External view of the left valve of the holotype. Fig. 3. Internal view of the right valve of the holotype. Fig. 4. External view of the right valve of the holotype, no locality given, BMNH (about 1x) [L=68 mm.].

Range. This species occurs along the Atlantic and Gulf coasts of the United States from Cape Hatteras, North Carolina south through the Florida Keys around the Gulf of Mexico to Matagorda Island, Texas. Records and ranges published by Dall (1889) and others mention the occurrence of this species in the Antillean and Caribbean areas. This is not probable, for specimens from Haiti, Santo Domingo, British Honduras, and Puerto Rico which have been examined appear to be referable to *Tellina angulosa* Gmelin.

Specimens examined. NORTH CAROLINA: Cape Hatteras; *Albatross I* station 2275, 19 miles NE of Cape Hatteras (35°20' N; 75°18' W), in 16 fathoms; *Albatross I* station 2112, 15 miles NNE of Cape Hatteras (35°20' N; 75°13' W), in 15½ fathoms; *Albatross I* station 2596, 19 miles SE of Cape Hatteras (35°05' N; 75°10' W), in 49 fathoms; *Albatross I* station 2609, 20 miles SEE of Cape Lookout (34°26' N; 76°12' W), in 22 fathoms; Fort Macon, Beaufort (all USNM); Bird Shoal, Beaufort; Shark Shoal, Boque Sound (both ANSP); Boque Id.; Shackleford Id. (both MCZ); Middle Sound, near Wilmington (USNM); Cape Fear, Smith Id. (ANSP). SOUTH CAROLINA: Merry's Inlet (MCZ); Cain Hoy, Wando (post Pliocene, USNM); Isle of Palms (CM; ANSP; MCZ); Charleston (CM; USNM; MCZ); Edisto Beach (CM). GEORGIA: Sea Id. (ANSP; MCZ); St. Simon's Bay (USNM). FLORIDA: Fernandino Beach (D. and N. Schmidt; USNM); Amelia Id. (ANSP; USNM); Mayport (ANSP); Jacksonville Beach (ANSP; MCZ); mouth of St. Johns River; St. Augustine (both ANSP); beach N of St. Augustine Inlet (MCZ); Matanzas Inlet (ANSP); 4 miles NE of Daytona Beach, in 10 fathoms (USNM); Coronado Beach; Cape Canaveral; Cocoa Beach; 2 miles SE of Cocoa Beach, in Banana River; Atlantic Beach (all MCZ); Fort Pierce, Hutchinson Id. (D. and N. Schmidt); North Inlet, Lake Worth (ANSP); off Lantana, in 70 fathoms; Fair Isle Basin, Biscayne Bay; Virginia Key (all MCZ); Hawk Channel, in 3–4 fathoms (USNM); 4 miles NNE of The Elbow, Key Largo, in 66 fathoms (MCZ); Lower Matecumbe Key; 3 miles SSE of Key West (both USNM); Boca Grande Key; NW of Dry Tortugas, in 10 fathoms (both MCZ); Madeira Bay, Florida Bay (CNM); Marco; Bonita Springs; Fort Myers Beach; Blind Pass, Sanibel Id. (all D. and N. Schmidt); 2 miles and 30 miles W of Sanibel Id. (both MCZ); Boca Grande, Little Gasparilla; Punta Gorda Beach (both ANSP); Charlotte Harbor; Long Boat Key; Anna Maria Key; Mullet Key (all USNM); Tampa Bay (ANSP; USNM); Treasure Id.; Boca Ceiga Bay (both MCZ); Pass-a-grille (USNM; MCZ); Clearwater (MCZ); Cedar Key (USNM; MCZ); Alligator Harbor (ANSP; MCZ); Indian Pass, Apalachicola Bay (ANSP); Port St. Joe (MCZ); Beacon Beach (ANSP); Panama City (USNM); Pensacola (MCZ). MISSISSIPPI: Horn Id. (ANSP). LOUISIANA: Chandeleur Id.; Grand Isle; Cameron; Grand Lake (all USNM). TEXAS: High Id., Bolivar Peninsula (MCZ); Galveston (ANSP; USNM; MCZ); Padre Id., Corpus Christi (USNM); Sebrile Banks, off Padre Id. (ANSP); Matagorda Id. (MCZ).

***Tellina (Eurytellina) tayloriana* Sowerby**

Plate 146, fig. 1

Tellina tayloriana Sowerby 1867 [*in*] Reeve, Conch. Icon., 17, *Tellina*, pl. 30, fig. 168 (Mexico) [type locality, here restricted, Tampico, Mexico; holotype, BMNH, no. 74.12.11.318].

Tellina taylora Sowerby 1867, American Jour. Conch., 3: 327, error for *tayloriana*.

Tellina (Eurytellina) tayloriana Sowerby. Olsson and Harbison 1953, Pliocene Mollusca of Southern Florida, Acad. Nat. Sci., Philadelphia, Monograph 8, p. 124, pl. 14, figs. 1-1b.

Description. Shell extending to 60 mm. (about $2\frac{1}{2}$ inches) in length and to 36 mm. (about $1\frac{1}{2}$ inches) in height, elongate subtrigonal, slightly inequilateral, slightly compressed with the right valve somewhat flattened, and with a weak flexure to the right posteriorly. Umbos only slightly behind the middle, little elevated, rather small and inconspicuous, and often sharply pointed. Anterior margin broadly and smoothly rounded; ventral margin usually slightly convex with a gently rising postbasal arcuation; anterior dorsal margin rather long, gently sloping and straight; posterior dorsal margin long, straight, and not steeply sloping; posterior margin short, straight, and at an angle to the dorso-ventral axis. In outline, the shell appears somewhat attenuate and truncate posteriorly. Sculpture consisting of incised concentric sulci, separated by broad bands. A discrepancy exists between the valves, the sulci are more dense on the right valve with concomitantly narrower bands. Ligament brown, protuberant and set in a narrow ill-defined escutcheon. The posterior dorsal slope of the left valve is flattened and broad. Calcareous portion of the ligament subtended by moderately developed nymphal callosities in both valves. Hinge line moderately developed. In the left valve, the cardinal complex consists of an anterior deltoid bifid tooth with subequal lobes and a posterior thin weak laminate cardinal tooth partly adpressed to the calcareous portion of the ligament and often broken or lost in some specimens; proximally anterior to the cardinal complex is a variously developed lateral tooth; the distal posterior lateral tooth is weak or obsolete. In the right valve, the cardinal complex consists of a posterior skewed, strong, deltoid bifid tooth with the posterior lobe the larger and of an anterior thin, elongate laminate cardinal tooth; anterior lateral tooth small and thin and very close to the laminate cardinal; posterior lateral rather well developed and distal to the cardinal complex. A heavy and well developed rib extends from the umbonal region to the anterior adductor scar in both valves. Adductor muscle scars well impressed. Pallial sinus rather variable, but usually subequal in each valve, flattened above, extending anteriorly but usually not contiguous with the anterior adductor. Sometimes an interlinear scar may connect the anterior adductor and the pallial sinus. The sinus falls rather abruptly and straight to the pallial line; confluence entire. Externally, the shell is white suffused with pink, with some alternations in bands of color, and with a darkening of the pink to nearly brownish peripherally. Internally, the shell is predominantly pink with some white suffusion and bands.

length	height	width	
57.8 mm.	34.5 mm.	11.7 mm.	Holotype of <i>tayloriana</i> Sowerby
60.0	36.0	11.5	Tampico, Mexico
54.5	30.5	11.5	Mustang Id., Texas
52.0	30.5	9.5	Corpus Christi, Texas
37.0	22.5	7.0	Port Isabel, Texas

Remarks. Heretofore, most authors, including Dall, have considered *Tellina tayloriana* Sowerby as a synonym of *Tellina alternata* Say. Recently Olsson and Harbison (1953) have differentiated these two species and have documented their occurrence in the Pliocene at Clewiston, Florida; they have gone so far as to infer that many fossil records of *T. alternata* are in reality those of *T. tayloriana*. Parker (1960) in his ecological studies of the macroinvertebrate fauna of certain areas along the Gulf of Mexico has recognized

the existence of *T. tayloriana* which he included as an important element in the inner shelf fauna (2–12 fathoms) along the coast of Texas.

In the Recent fauna, *Tellina tayloriana* appears to possess a discontinuous distribution; however, the records of the occurrence of this species along the Atlantic coast of Florida near St. Augustine and the area around Charleston, South Carolina are of doubtful authenticity. Notwithstanding these reservations, the central populations of *tayloriana* are to be found west of the Mississippi River.

There is no doubt that *tayloriana* and *alternata* are extremely closely related, but enough characteristics appear to distinguish each so that the treatment accorded these species by Olsson and Harbison seems justified. In color, *tayloriana* is bright pink, and this coloration appears to be present through the whole shell and is not disposed in distinct rays or patterns. The interior of the valves are generally highly polished with strong muscle impressions and a well differentiated and broad anterior radial rib. In contrast to *T. alternata*, the internal cavity of *tayloriana* is narrower, a trait reflected by the shallowness of the concavity of both valves. The right valve of *tayloriana* is noticeably more flat than that of *alternata*. The anterior dorsal marginal plate, present in each valve and adpressed when the valves are closed, is broad and flattened; in the right valve this structure carries the anterior lateral tooth. Externally, the anterior dorsal surface of the left valve possesses in a well developed state the concentric sculptural pattern; in *alternata*, the concentric sulci in this region are less well defined, poorly developed and more widely separated by concentric bands. It appears that *tayloriana* and *alternata* may be ecologically separated; there is some evidence which indicates that *tayloriana* lives in off-shore waters at greater depths than *alternata*.

Range. This species appears to be localized along the Gulf Coast of Texas and Mexico; the records from South Carolina and Florida are subject to questionable authenticity.

Specimens examined. SOUTH CAROLINA: Charleston (MCZ). FLORIDA: St. Augustine (USNM; MCZ). TEXAS: High Id., Bolivar Peninsula (ANSP); Galveston (ANSP; MCZ); Matagorda Id. (USNM; MCZ); Port Aransas (ANSP; MCZ); Mustang Id.; Corpus Christi (both MCZ); Freeport (Bulloch); Port Isabel; Boca Chica Beach, 3 miles N of Rio Grande (both MCZ); Brazas Id. (ANSP); Rio Grande (USNM). MEXICO: Tampico; Tuxpan; 15 miles N of Tecolutla (all MCZ).

***Tellina (Eurytellina) nitens* C. B. Adams**

Plate 147, figs. 3–4; Plate 148, fig. 1; Plate 149, fig. 4; Plate 150, fig. 1

Tellina nitens Adams 1845, Proc. Boston Soc. Nat. Hist., 2: 10 (Jamaica), *non* Deshayes 1854, *nec* Gregorio 1890, *nec* 'Lea' Dall 1900; Clench and Turner, 1950, Occ. Papers. Moll., Harvard University, 1(15); 317, pl. 44, figs. 3–4 [holotype, MCZ 155606].

Tellina (Angulus) nitens Adams. Tryon 1869, American Jour. Conch., 4: 94.

Tellina nitida Lamareck var. *Carolinensis* Dall 1889, Bull. U.S. Nat. Mus., 37: 60, *non* Conrad 1875 (*nomen nudum*).

Tellina (Eurytellina) georgiana Dall 1900, Proc. U.S. Nat. Mus., 23: 294, 310, pl. 2, fig. 3 (*Albatross I* station 2387, 66 miles S of Mobile Bay, Gulf of Mexico (29°34' N; 88°04' W), in 32 fathoms) [holotype, USNM 93777], *non* Gabb 1876.

Tellina (Eurytellina) inaequistriata 'Donovan' Dautzenberg 1900, Mem. Soc. Zool., Paris, 13: 260, *non* Donovan 1802.

Description. Shell extending to 39 mm. (about $1\frac{1}{2}$ inches) in length and to 21 mm. (about $\frac{3}{4}$ inch) in height, elongate-elliptical, slightly inequilateral, moderately compressed with the left valve markedly more convex than the right and equivalve with a very slight posterior flexure to the right. Umbos just posterior to the middle, somewhat inflated, slightly raised above the hinge line and somewhat pointed. Anterior margin smoothly and narrowly rounded; ventral margin straight, rising gently posteriorly; anterior dorsal margin long, gently sloping and slightly convex; posterior dorsal margin variable in

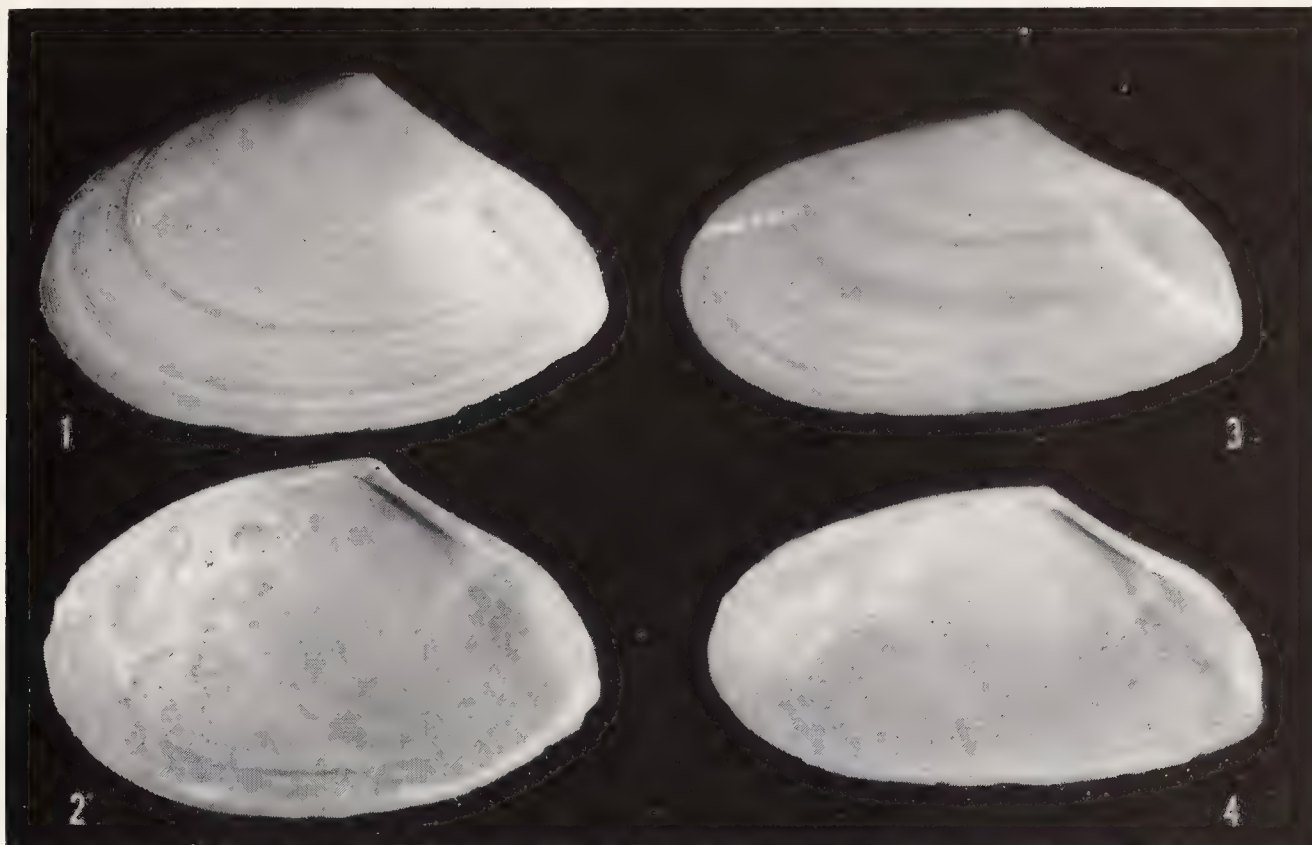


Plate 147. Figs. 1-2. *Tellina decussatula* C. B. Adams [= *Tellina lineata* Turton]. Fig. 1. External view of the left valve of the lectotype. Fig. 2. Internal view of the right valve of the lectotype, Jamaica, MCZ 156459 (about 2.4x) [L=25 mm.]. Figs. 3-4. *Tellina nitens* C. B. Adams. Fig. 3. External view of the left valve of the holotype. Fig. 4. Internal view of the right valve of the holotype, Jamaica, MCZ 155606 (about 3x) [L=18.5 mm.].

length, straight and gently sloping; posterior margin straight and at an angle to the dorso-ventral axis. In outline, the posterior portion of the shell appears attenuate, truncate and slightly alate above. Sculpture consisting of finely incised concentric sulci separated by narrow bands; various irregularities occur over the disc where some sulci tend to assume a pattern out of phase with the concentric growth lines. The posterior portion of the right valve is characterized by stronger, less dense concentric bands or riblets. Posterior ridge well developed in the right valve and with a concomitant sulcus in the left; the peculiar posterior riblet sculpture begins either just anterior to or upon the posterior ridge. Ligament light brown, strong, somewhat sunken in a narrow deep esutcheon. Calcareous portion of the ligament subtended by poorly developed nymphal callosities. Hinge line moderately developed. In the left valve, the cardinal complex consists of an anterior, narrow, weak, bifid tooth with subequal lobes and a posterior thin laminate tooth adpressed to the calcareous portion of the ligament and often broken or lost; subproximal anterior lateral tooth weak or obsolete; distal posterior lateral tooth rather poorly developed and weak but stronger than the anterior lateral. In the right

valve, the cardinal complex consists of a posterior, strongly skewed, usually strong, bifid tooth with the posterior lobe the larger, and an anterior thickened, subdeltoid, strong laminate cardinal tooth; the anterior lateral tooth is subproximal to the laminate of the cardinal complex, strong and well developed; the posterior lateral tooth is distal, moderately well developed and slightly weaker than the anterior lateral. A radial rib extends from the umbonal region to the anterior adductor scar and it is stronger in the left valve. Adductor muscle scars fairly well impressed. Pallial sinus convex above with a slight apex in front of the posterior adductor, extending nearly to the anterior adductor scar but most often not touching it. The pallial sinus descends in an arcuation to the pallial line; confluence entire. Externally, the shell is pink or apricot in color with some interspersed bands of white; the posterior slope tends to be whitish; internally, a pink or apricot color suffused with white occurs; the periphery is white.

length	height	width	
18.5 mm.	10.5 mm.	4.0 mm.	Holotype of <i>nitens</i> Adams
32.2	17.2	7.1	Holotype of <i>georgiana</i> Dall
39.1	21.3	8.2	Montego Bay, Jamaica
28.0	15.2	6.5	Lucea Bay, Jamaica
24.5	14.0	5.5	off Port Isabel, Texas
11.2	6.2	2.2	<i>Albatross I</i> station 2610, 34°20' N: 76°12' W, 27 miles SE of Cape Lookout, North Carolina

Remarks. *Tellina nitens* is distinguished from all its near relatives in the subgenus *Eurytellina* by a peculiar vitreous, apricot-colored external surface and an intercalated concentric sculpture along the posterior slope of the right valve. Dall originally related

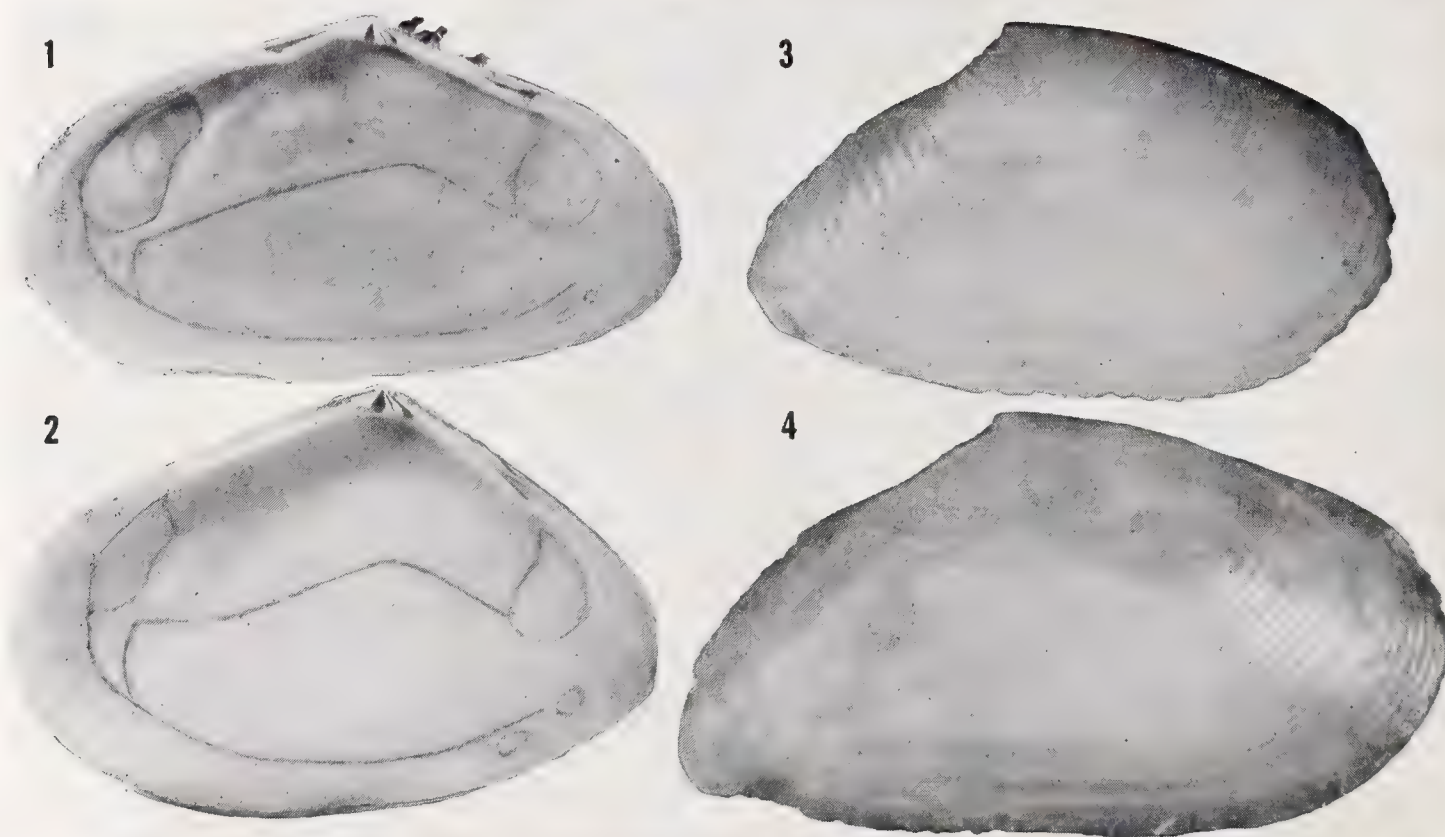


Plate 148. Fig. 1. *Tellina nitens* C. B. Adams, internal view of the right valve, Lucea Bay, Jamaica, MCZ 212137 (about 2.6x) [L=26 mm.]. Fig. 2. *Tellina angulosa* Gmelin, internal view of the right valve, St. Croix, Virgin Islands, MCZ 236382 (about 1.4x) [L=48 mm.]. Figs. 3-4. *Tellina vespuciana* d'Orbigny. Fig. 3. External view of the right valve, Livingston, Guatemala, MCZ 239109 (about 11x) [L=6 mm.]. Fig. 4. External view of the right valve of a syntype, Jamaica, BMNH (about 12x) [L=6.5 mm.].

this species to *Tellina nitida* Lamarck of European seas and called it a variety, *carolinensis*. Later, he recognized its distinctiveness and placed it within *Eurytellina* as *T. georgiana*, a name preoccupied by Gabb. Superficially, *T. nitida* may be confused with *T. nitens*, but the former lacks the eurytellinid syndrome, particularly the developed lateral teeth in the right valve. With some specimens of *T. alternata*, *nitens* may be confounded, but the former lacks a differentiated posterior slope sculpture in the right valve. In point of fact, the anterior right lateral tooth of *T. nitens* is farther removed from the cardinal complex than it is in *alternata*, *punicea* or *angulosa*, and in respect to this character, *nitens* most closely approaches *T. guildingii*. However, *T. guildingii* may readily be distinguished from *nitens* by its closely set, finely incised, concentric sulci and its radial color pattern. To *T. vespuciana*, the smallest and apparently one of the rarest *Eurytellina* of the Western Atlantic, *nitens* is also closely allied by the differential sculpture on the posterior slope of the right valve, but in *vespuciana* this sculpture tends only to be stronger and not intercalated as it is in *nitens* and the strength of the posterior ridge and posterior flexure to the right, in *vespuciana*, are adequately distinctive traits.

Among some of the variations apparent in *Tellina nitens*, none is so obvious as the difference in coloration. Some individuals are apricot or peach in color with brilliantly lustrous surfaces whereas others tend toward pink suffusions and still fewer tend to be

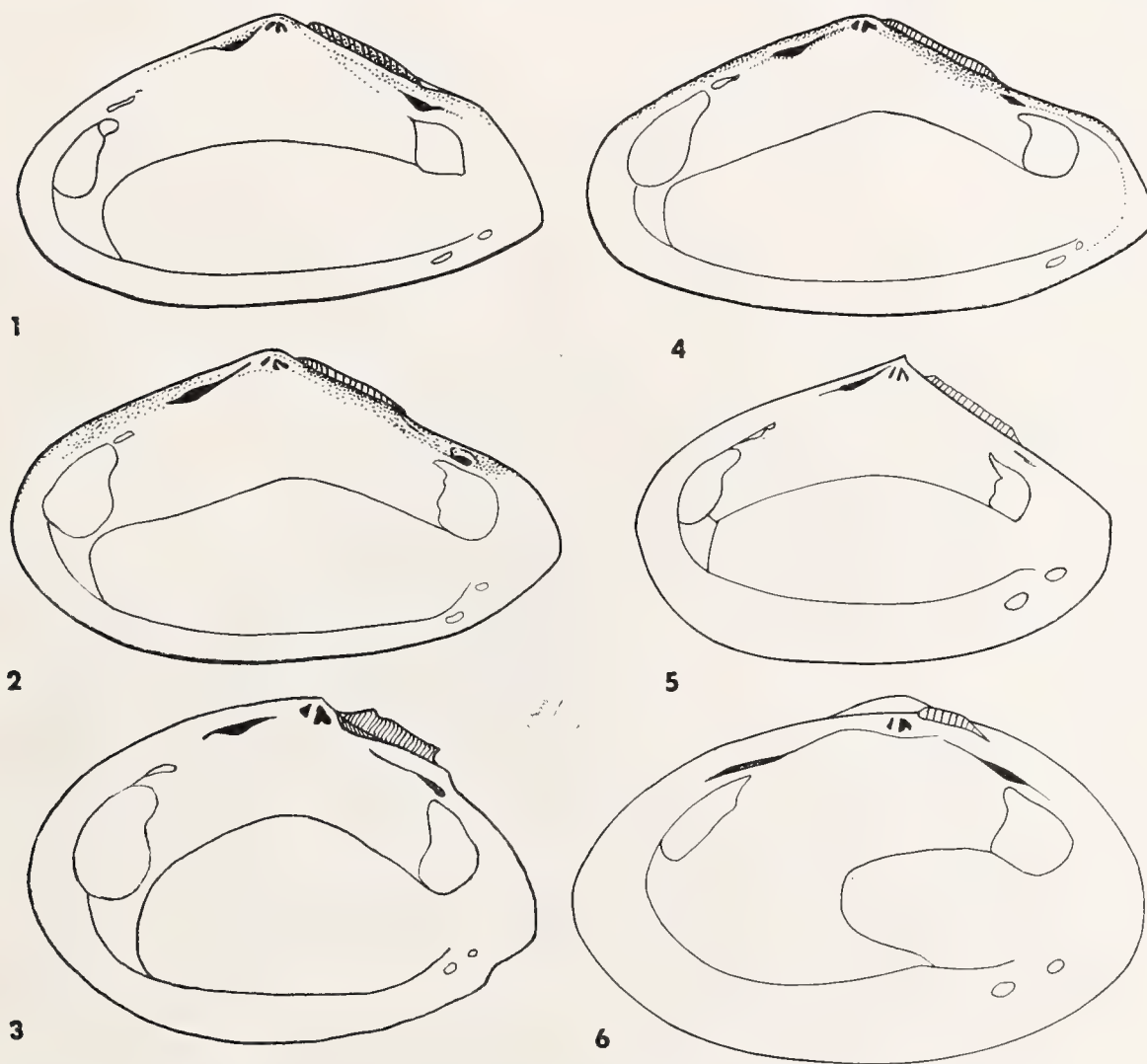


Plate 149. Figs. 1-6. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina vespuciana* d'Orbigny (about 9x) [L=6 mm.]. Fig. 2. *Tellina guildingii* Hanley (about 2x) [L=30 mm.]. Fig. 3. *Tellina lineata* Turton (about 1.9x) [L=30 mm.]. Fig. 4. *Tellina nitens* Adams (about 2x) [L=30 mm.]. Fig. 5. *Tellina trinitatis* Tomlin (about 1.5x) [L=32 mm.]. Fig. 6. *Tellina americana* Dall (about 9x) [L=7 mm.].

more predominantly white. The placement of the pallial sinus is not always constant; in some specimens, the pallial sinus appears to be coalescent with the anterior adductor muscle scar whereas in others it falls just short of connecting to the scar; even opposite valves may be unlike in this regard. The umbos are particularly pointed, protuberant and conspicuous in the young of *nitens*, and the prodissoconch is smooth, shining and often devoid of any indication of sculpture.

In the Eastern Pacific, *Tellina inaequistriata* Donovan represents the nearest ally to *T. nitens*. They are no doubt analogous and have arisen from a common stock. Records from the Western Atlantic which have cited the occurrence of *T. inaequistriata* represent *T. nitens*. The species are similar in proportion and in coloration but they may be separated by the differentiated posterior slope sculpture which in *inaequistriata* is more extensive, being found on the posterior portion of the disc and the concentric sculpture itself appears to be finer. According to Olsson (1961), *T. inaequistriata* is unique in the possession of fine crenulations along the anterior ventral margin of the shell.

The fossil history of *Tellina nitens* may be traced back to the Lower Miocene, and fossil species which apparently are antecedents of *nitens* have been found in numerous Tertiary deposits in the Caribbean area. Olsson and Harbison (1953) have described *Tellina strictolineata* from the Pliocene of southern Florida, and Woodring (1925) has figured, from the Miocene Bowden marls of Jamaica, *Tellina browni* which has an outline as well as the protuberant umbos similar to *Tellina nitens*. *Tellina hallistrepta* Dall (1900b) from the Bowden formation appears to be more closely allied to *Tellina (Phyllodina) persica*. In all these cases, the resemblance of the fossil to the living species is obvious and each species might be assumed to be a precursor to the Recent form. It is of interest to note that there appears to be a trend in the phylogeny of *Tellina nitens*. The characteristic intercalated sculpture of the posterior slope seems to have progressed posteriorly, for in the Miocene species and even in the Pliocene species, the extent of the peculiar sculpture is greater. In the fossil species, this sculpture occurs on part of the disc as well as on the posterior slope and through time the extent of this sculpture has been gradually diminished, so that in *nitens*, it is more or less limited to the bounds of the posterior slope.

Range. This species is found as far north as Cape Hatteras, North Carolina and as far south as Tobago in the Lesser Antilles; it occurs in the Gulf of Mexico along the southwestern coast of Texas and the western tip of Pinar del Rio, Cuba.

Specimens examined. NORTH CAROLINA: *Albatross I* station 2276, 17 miles NNE of Cape Hatteras (35°20' N; 75°19' W), in 16 fathoms; *Albatross I* station 2596, 19 miles SE of Cape Hatteras (35°08' N; 75°10' W), in 49 fathoms; *Pelican* station 190-1, 9 miles SW of Cape Hatteras (35°06' N; 75°32' W), in 11 fathoms; *Albatross I* station 2610, 27 miles SE of Cape Lookout (34°20' N; 76°12' W), in 22 fathoms. FLORIDA: 3½ miles NE of Pacific Reef, in 66 fathoms; 2½ miles SSE of Looe Key, in 37 fathoms; Western Dry Rocks; Dry Tortugas (all MCZ). TEXAS: about 68 miles SE of Freeport, in 48 fathoms; about 80 miles S of Port Isabel, in 40 fathoms (both MCZ). CUBA: *Barrera* station 200, Santa Lucia, in 2-4 fathoms; *Barrera* station 208, Bahia Honda, in 1-12 fathoms; *Barrera* station 203, Cabanas Harbor, in 3-12 fathoms (all USNM); Caibarien; Fish Point, Guantánamo Bay (both MCZ). JAMAICA: Green Island Bay; Lucea Bay (both MCZ); Montego Bay (USNM); Port Antonio (MCZ; USNM).

HISPANIOLA. HAITI: Saltrou (USNM). PUERTO RICO: mouth of Anasco River, in 40–60 feet (IMBPR); Mayaguez Harbor, in 10–13 fathoms (USNM; MCZ); La Parguera (MCZ); Salinas Beach, near Guanica (IMBPR); Farjado (MCZ); Johnson Smithsonian Station 75, off Palominas Id., in 26 fathoms (USNM). LESSER ANTILLES: St. Johns, Antigua, in 5 fathoms (ANSP); English Harbour, Antigua, in 7 fathoms; St. Lucia, in 7 fathoms; St. Lucia, in 10 fathoms; Carlisle Bay, Barbados, in 12 fathoms (all USNM); 2 miles S of Scarborough, Tobago, in 36 fathoms (MCZ).

***Tellina (Eurytellina) guildingii* Hanley**

Plate 149, fig. 2; Plate 151, figs. 1–2

Tellina guildingii Hanley 1844, Proc. Zool. Soc. London, **12**: 60 (West Indies); 1846. Thesaurus Conchyliorum, **1**: 230, pl. 56, fig. 1 [type locality, here restricted, White River Beach, Jamaica: holotype, BMNH].

Tellina (Tellinella) guildingii Hanley. Bertin 1878, Nouvelles Arch. Mus. (2nd series), Paris, **1**: 240.

Tellina (Tellina) guildingii Hanley. Aguayo y Jaume 1949, Catalogo Moluscos de Cuba, no. 592.

Tellina (Arcopagia) guildingii Hanley. McLean 1951, New York Acad. Sci., **17**(1): 94.

Description. Shell extending to 53 mm. (about 2 inches) in length and to 30 mm. (about 1½ inches) in height, elongate-elliptical, thin to subsolid, slightly inequilateral, moderately compressed but with the left valve markedly more convex and with a slight posterior flexure to the right. Umbos just behind the middle, slightly elevated above the hinge line and rather blunt. Anterior margin smoothly and somewhat narrowly rounded; ventral margin straight, rising only slightly posteriorly; anterior dorsal margin gently sloping but stronger in its descent to the anterior dorsal margin; posterior margin more or less straight, at an angle to the dorso-ventral axis and forming an oblique truncation. Sculpture consisting of rather deeply incised, closely set, concentric sulci separated by narrow, crowded bands; radial lirations are variously developed, cover the disc and are

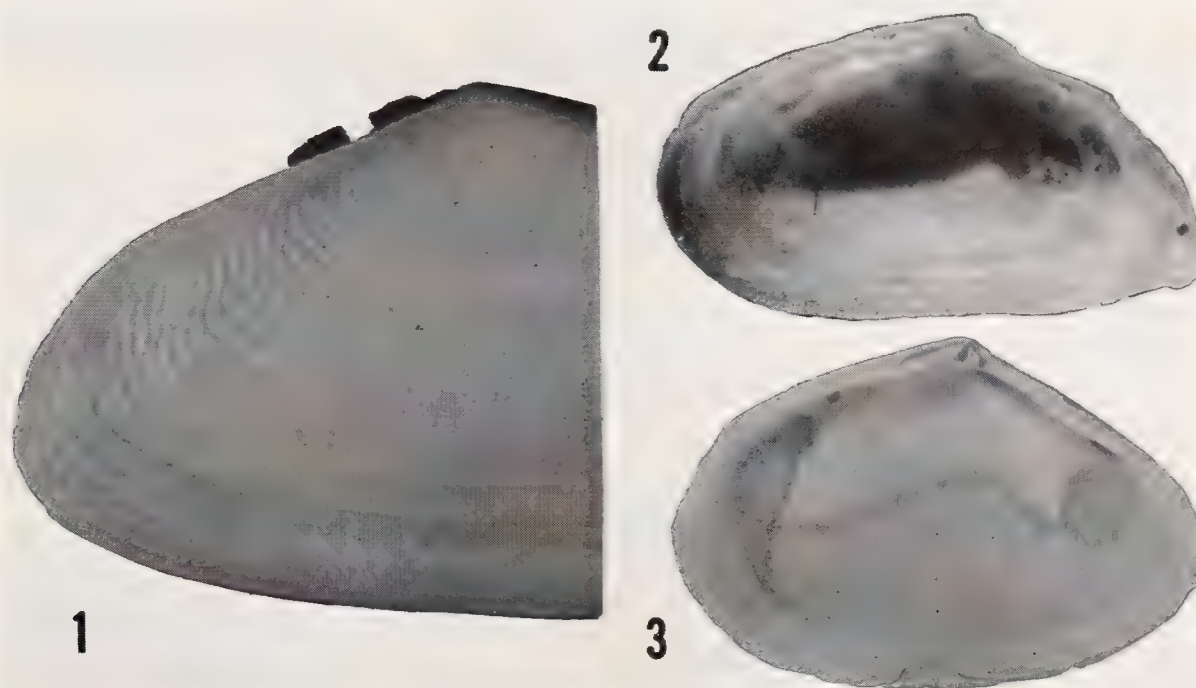


Plate 150. Fig. 1. *Tellina nitens* C. B. Adams, external view of the posterior dorsal slope of the right valve, Lucea Bay, Jamaica, MCZ 212137 (about 4x) [L=about 15 mm.]. Fig. 2. *Tellina vespuciana* d'Orbigny, internal view of the right valve of a syntype, Jamaica, BMNH (about 8.7x) [L=6.5 mm.]. Fig. 3. *Tellina punicea* Born, internal view of the right valve, Guayaguayare Beach, Trinidad, MCZ 236375 (about 1.6x) [L=35 mm.].

more or less absent from the posterior slope and its vicinity. Ligament short, thick, dark to light brown, somewhat protuberant, set in a shallow elongate escutcheon. Calcareous portion of the ligament subtended by a short strong nymphal callosity, especially in the right valve. Hinge moderately well developed. In the left valve, the cardinal complex consists of an anterior, narrow, bifid tooth whose anterior lobe is much the larger and a posterior, thin, laminate tooth which is adpressed to the calcareous portion of the ligament and which is often broken or lost; the anterior lateral tooth is somewhat removed from the cardinal complex, subproximal rather than distal to it and extremely poorly



Plate 151. *Tellina guildingii* Hanley. Fig. 1. External view of the right valve of the holotype, West Indies, BMNH (about 3.2x) [L=29.8 mm.]. Fig. 2. External view of the right valve, White River Beach, Jamaica, MCZ 208598 (about 2.4x) [L=34 mm.].

developed; the posterior lateral tooth is distal and variously developed although never strong. In the right valve, the cardinal complex consists of a posterior, strongly skewed, moderately strong, bifid tooth with subequal lobes and an anterior, thickened, well developed subdeltoid laminate tooth; the strong anterior lateral tooth is proximal to the laminate of the cardinal complex; the posterior lateral tooth is distal to the cardinal complex, moderately developed but markedly weaker than the anterior lateral. An internal rib extending from the umbonal area to the anterior adductor muscle scar is well developed in both valves. Adductor muscle scars strongly impressed. Pallial sinus flattened to convex above, extending to and (in younger specimens) coalescing with the anterior adductor scar and falling abruptly with a slight arcuation to the pallial line; confluence entire. Externally, the shell is predominantly white, sometimes with concentric bands of orange or red and usually with radial bands of orange or red which widen peripherally. Inter-

nally, the shell is usually completely white but the transparency of the shell allows the radial and concentric pattern of the external surface to show through.

length	height	width	
29.8 mm.	16.0 mm.	7.0 mm.	Holotype of <i>guildingii</i> Hanley
53.5	29.5	—	Bermuda
37.9	29.9	7.8	Rio Bueno, Trelawny, Jamaica
37.4	29.9	7.5	White River Beach, Ocho Rios, Jamaica
34.6	18.2	6.6	White River Beach, Ocho Rios, Jamaica
31.5	14.5	7.5	St. Croix, Virgin Islands

Remarks. This species, as rare as it is and distributed as it is over a wide range, is nevertheless distinct from all the other Western Atlantic *Tellina*. It is not synonymous with *T. nitens* as McLean (1951) has indicated. Of all the Western Atlantic *Eurytellina*, *nitens* is probably the most closely related species to *guildingii*. The latter, however, is immediately characterized by its concentric sculpture which is strong, deeply incised and closely set; in addition, the peculiar orange sheen of *nitens* is completely lacking in *guildingii*, which instead has a distinctly rayed pattern of coloration. The valves of *guildingii* are heavier and thicker than those of *nitens* and there is no intercalated sculpture on the posterior slope of the right valve. Unfortunately, there is no information as to the habitat preferred by this species. *Tellina waylandvaughani* described by Maury (1917) from the Lower Miocene of Santo Domingo bears some resemblance to the shape and outline of *guildingii*.

Range. This species is rare and poorly represented in museum collections. The Bermuda record from a lot in the MCZ is doubtful, and Peile (1926) does not list this species from there. The lot from Dick's Point, Nassau, New Providence in the Bahamas is also doubtful. It is certain, however, that the species is to be found in Jamaica and that it also probably occurs in the Virgin Islands; such a discontinuous distribution will only be corroborated with further collecting in other Antillean areas.

Specimens examined. BERMUDA: Bermuda (MCZ). BAHAMA ISLANDS: Dick's Point, Nassau, New Providence (MCZ). CUBA: *Atlantis* station 3328, Bahia Cochinas, 22°08' N: 81°10' W, in 260–275 fathoms (MCZ). JAMAICA: Rio Bueno, Trelawny (USNM); White River Beach (Yale; USNM; MCZ). VIRGIN ISLANDS: St. Thomas (ANSP); St. Croix (MCZ). LESSER ANTILLES: off Pelican Island in 100 fathoms and in Carlisle Bay in 12 fathoms, both Barbados (both MCZ).

Tellina (*Eurytellina*) *lineata* Turton

Plate 143, figs. 3–4; Plate 147, figs. 1–2; Plate 149, fig. 3

Tellina striata 'Gmelin' Montagu 1804, Testacea Britannica, pp. 60 and 61, *non* Gmelin 1792, *nec* Spengler 1798, *nec* Costa 1829.

Tellina brasiliiana Lamarck 1818, Animaux s. Vertebres, 5: 532 (l'Océan du Brésil, à Rio de Janeiro) [syn-types, Museum d' Histoire Naturelle, Paris], *non* Spengler 1798.

Tellina lineata Turton 1819, Conch. Dict., p. 168, pl. 4, fig. 16 (coast of Dorsetshire) [type locality, here corrected and restricted, Jamaica; holotype, USNM 172658], *non* Hoeninghaus 1829.

Tellina decussatula C. B. Adams 1845, Proc. Boston Soc. Nat. Hist., 2: 10 (Jamaica); Clench and Turner 1950, Occ. Papers Moll., Harvard University, 1(15): 272, pl. 44, figs. 1–2 [lectotype, selected by Clench and Turner, MCZ 156459].

Tellina (*Tellinella*) *lineata* Turton. H. and A. Adams 1856, Genera Recent Mollusca, 2: 395 (error for *Tellinella*).

Tellina (*Tellinella*) *lineata* Turton. Römer 1871, Conchilien-Cabinet (2), **Tellina**, 10(4): 53, pl. 15, figs. 8-12.

Tellina decussata Adams. Krebs 1864, West Indian Shells, p. 101 (error for *decussatula*), *non decussata* Lamarck 1818.

Tellina (*Tellina*) *lineata* Turton. Dall 1900, Proc. U.S. Nat. Mus., 23: 293.

Tellina (*Moerella*) *lineata* Turton. Dautzenberg 1900, Mem. Soc. Zool., Paris, 13: 261.

Tellina (*Eurytellina*) *lineata* Turton. Dall and Simpson 1901, Bull. U.S. Fish. Commission, 20(1): 480.

Tellina (*Tellina*) *decussata* Adams. Maury 1920, Bull. American Paleo., 8(34): 79 (error for *decussatula*).

Description. Shell extending to 38 mm. (about 1½ inches) in length and to 25 mm. (about 1 inch) in height, subtrigonal or elongate-oval, inequilateral, somewhat inflated with both valves of nearly equal convexity and with a marked and sharp flexure to the right. Umbos raised slightly above the hinge line, inflated with a cavity below, pointed, markedly opisthogyrous and located just posterior to the middle. Anterior margin more or less broadly rounded; ventral margin straight or convex and gently rising; anterior dorsal margin convex, short and gently curving; posterior dorsal margin rather steeply sloping; posterior margin more or less straight, short and forming an oblique truncation. Sculpture consisting of rather closely set, weakly incised, concentric sulci separated by narrow and hardly raised bands of irregular breadth. Weak and broad radial lirations cover the disc. Posterior ridge present but generally not too well developed and stronger on the left valve. Ligament generally dark brown, short, broad and sunken into a broad but shallow escutcheon. Calcareous portion of the ligament very much narrowed posteriorly and subtended by a nymphal callosity, which is rather well developed in the right valve. Hinge line well developed. In the left valve, the cardinal complex consists of an anterior, elongate, bifid tooth with subequal lobes and a posterior narrow and weak laminate tooth which is adpressed to the calcareous element of the ligament; the anterior lateral tooth subproximal, weak and obsolete; the posterior lateral tooth distal, slightly stronger than the anterior but still rather poorly developed. In the right valve, the cardinal complex consists of a posterior, skewed, strong, bifid tooth with irregular lobes and an anterior subdeltoid, strong laminate tooth; the anterior lateral tooth is subproximal to the cardinal complex, strong and well developed; the posterior lateral is weaker and distal. A variously developed anterior rib extends from the umbonal area to the anterior adductor scar. Adductor muscle scars well impressed. Pallial sinus convex above, not rising above the adductor muscle scars, extending anteriorly but usually not coalescing with the anterior adductor scar and falling more or less obliquely to the pallial line; confluence entire. Externally, the shell may be pure white to pure pink; in specimens with pink concentrated on the disc, there are evidences of concentric banding of white and pink. Some suffusion of yellow and apricot may also appear. Internally, the shell is white, pink, or a mixture thereof; the marginal borders are generally white.

length	height	width	
25.0 mm.	16.0 mm.	7.5 mm.	Lectotype of <i>decussatula</i> Adams
37.5	24.5	11.6	Marco Pass, Florida
35.5	23.0	12.0	Marco Pass, Florida
34.0	24.0	11.5	Marco Pass, Florida
31.5	21.0	8.5	Isla Coche, Venezuela
16.0	10.5	5.0	Cape Sable, Florida

Remarks. The inclusion of Montagu's interpretation of Gmelin's *striata* in the synonymy is made because of Turton's reference to Montagu in the type description of *lineata*, and all later authors have interpreted Montagu's remarks as being descriptive of Turton's *lineata*. Under the synonyms of *T. lineata* Turton, Dall (1900a) listed Conrad's reference to *Tellina tenuis* daCosta in Say's American Conchology; the specimen figured by Conrad later became the type of *Tellina omoia* Ravenel, which is herein treated as a *nomen oblitum* under *Tellina colorata* Dall.

The range of variation within this species is in part responsible for the synonyms cited above. Certainly the most characteristic trait for this species is the strong posterior flexure to the right, which is absent or only poorly developed in other species in the subgenus *Eurytellina*. Dall (1900a) had tentatively placed it within the framework of the subgenus *Tellina*, as interpreted by him. In the present thesis the concept of *Eurytellina* has been broadened to allow inclusion of *T. lineata*. This species possesses a variously developed internal anterior rib which extends between the umbonal area and the scar of the anterior adductor muscle. The anterior lateral tooth in adult specimens is subproximal and in immature and very young specimens, it appears to be distal. The extent and shape of the pallial sinus is also variable, the distance separating the anteriormost border of the sinus and the scar of the anterior adductor muscle is not constant. The sinus may fall straight or obliquely to its union with the pallial line. In color, *lineata* ranges between a pure white and a pure pink with numerous gradations between, including suffusions of yellow and apricot. As far as can be ascertained, this range of coloration is found within any local population and there does not appear to be any clinical phenomenon involved. As indicated by the measurements, the same may be said for the astonishing variation in shape. In similar localities, shells may be markedly subtrigonal, elongate, subquadriform, or subovate; however, in youthful stages, there is a tendency for the shell to appear quadriform in outline. The posterior dorsal slope may incline steeply or gently, the ventral margin may be straight or convex, and the posterior portion of the shell may appear produced, truncated, or bluntly rounded. Nevertheless, the species is well characterized by its adult dentition, the posterior flexure, the subequal convexity of the valves and the rather conspicuously pointed and strongly opisthogyrous umbo.

The affinities of *Tellina lineata* are somewhat obscured, for there are no documented fossil records and no apparent predecessor species (Maury, 1920). In the fauna of the Eastern Pacific, there is no distinct analog and the closest relatives of this species in the Western Atlantic appear to be *T. nitens* and *T. punicea*. The similar placement of the right anterior tooth as well as the configuration of the pallial sinus are indicative of the propinquity of *nitens* and *lineata*, but *nitens* possesses a distinct and distinguishing intercalated sculpture on the posterior slope of the right valve and lacks the tumidity and convexity of *lineata*. *Tellina punicea* is even more distantly related, for its right anterior lateral tooth is closer to the cardinal complex than that of *lineata*. In addition, it is of a much more elongate shape with lower proportions and the posterior flexure is but poorly developed. It is to be concluded that *T. lineata* stands more or less alone in the Western Atlantic fauna and that even from its nearest relatives it is quite widely divergent and unique.

Certain species may be superficially confused with *Tellina lineata* but each is easily distinguished by close examination. *Tellina tampaensis*, when compared with *lineata*, shows a lack of a developed right posterior lateral tooth and its pallial sinus is distinctly

separated from the anterior adductor muscle scar. *Macoma cerina* 'C. B. Adams' Dall appears to have some similarity in outline to *T. lineata* but the former totally lacks lateral teeth.

Range. This species occurs as far north as St. Augustine, Florida; it is found along the coast of the Gulf of Mexico from Florida to Yucatan. It appears to be very rare in the Bahamas. It occurs throughout the Greater and Lesser Antilles, in the Caribbean Sea, along the coast of eastern Central America and northern South America, and along the shores of eastern South America to São Paulo, Brasil.

Specimens examined. FLORIDA: St. Augustine (USNM); Banana River, near Cocoa Beach (MCZ); Jupiter Inlet (ANSP); mouth of St. John's River (USNM); Lake Worth; North Inlet, Palm Beach (both ANSP); Pelican Shoals; Middle Cape and North Cape, Cape Sable; Small Key, 7½ miles NNW of Lostman's River; Plover Key (all MCZ); Lostman's Key (ANSP); Pavilion Key (MCZ); Cape Romano (USNM); Cape Haze; Horse Key, 11½ miles SE of Marco; Caxambas Pass (all MCZ); Marco, in 2 fathoms; Marco Pass (both USNM); Naples (MCZ); Bonita Beach, Bonita Springs (ANSP; MCZ); Big Carlos Pass; Fort Myers Beach (both ANSP); Bunch Beach (D. and N. Schmidt); Punta Rassa (D. and N. Schmidt; ANSP; USNM; MCZ); Tarpon Bay and Blind Pass, Sanibel Id.; Captiva; Charlotte Harbor (all MCZ); Gasparilla Key (USNM); Little Gasparilla Id. (ANSP); Lemon Bay; Sarasota Bay; Pass-a-grille (all MCZ). TEXAS: Port Aransas (MCZ). MEXICO: Veracruz (USNM; MCZ); Isla del Carmen, and near Chenkan, Campeche; Yucatan (all MCZ). GUATEMALA: Puerto Barrios (MCZ). NICARAGUA: (ANSP). BAHAMA ISLANDS: Abaco (ANSP). CUBA: *Barrera* station 209, Santa Rosa, in 3–6 fathoms (USNM); Veradero Beach, Matanzas (MCZ); Playa Larga, Cardenas (CNM); Cayo Frances, and Cayo Conuco, Caibarien; Nicaro, Mayari (all MCZ); Batabano (ANSP); Nueva Gerona, Isla de Pinos (MCZ); Sigüanea Bay, and Punta Colombo, Isla de Pinos (both USNM); ½ mile E of La Milpa, Cienfuegos Bay (MCZ); Cienfuegos Harbor; Ensenada de Cochinos, in 100–150 fathoms (both USNM). JAMAICA: Mamee Bay, St. Anne's Parish (MCZ); Old Harbor, St. Catherine; Hunts Bay; Kingston; Palisadoes (all USNM). HISPANIOLA. HAITI: Ile a Vache; Les Cayes; St. Louis de Sud; Aquin; Bizoton (all USNM). SANTO DOMINGO: Santa Barbara de Samana (MCZ). PUERTO RICO: Catano (IMPBR); Cabras Id.; Mayaguez (both USNM); Salinas de Guanica (IMBPR); El Caja de Santiago (USNM). VIRGIN ISLANDS: St. Thomas (USNM). LESSER ANTILLES: Guadeloupe; St. Lucia (both ANSP); Grenada (USNM); Trinidad (MCZ). COLOMBIA: Cartagena (MCZ). VENEZUELA: Isla Coche; Cumana; Margarita Id. (all MCZ). BRASIL: Fortaleza (USNM); Recife; Ilha de Itaparica, Bahia; Vitoria, Espirito Santo (all MCZ); São Sebastião, São Paulo (USNM).

Tellina (Eurytellina) vespuciana d'Orbigny

Plate 148, figs. 3–4; Plate 149, fig. 1; Plate 150, fig. 2

Tellina vespuciana d'Orbigny 1842 [*in*] Sagra, Hist. L'Ile Cuba, Atlas, pl. 26, figs. 12–14; 1845, Spanish Text, 5(2): 305 (Martinica y Jamaica); 1853, French Text, Mollusques, 2: 254 [type locality, here restricted, Jamaica; syntypes, BMNH 54.10.4.515].

Tellina (Arcopagia) vespuciana d'Orbigny. McLean 1951, New York Acad. Sci., 17(1): 93, pl. 19, fig. 5.

Tellina (Eurytellina) vespuciana d'Orbigny. Warmke and Abbott 1961, Caribbean Seashells, p. 196.

Description. Shell extending to 7.5 mm. in length (about 5/16 inch) and to 4.5 mm. (about 3/16 inch) in height, elongate, subsolid, moderately inflated, with the left valve of markedly greater convexity and with a flexure to the right posteriorly. Umbos posterior to the middle, opisthogyrous, not elevated and pointed. Anterior margin somewhat broadly rounded; ventral margin more or less straight, rising in a gentle arcuation posteriorly; anterior dorsal margin steeply inclined and convex; posterior margin more or less straight and forming a broad truncation. Sculpture consisting of incised concentric sulci separated by narrow, rather flattened bands; the concentric sculpture increasing in strength along the posterior ridge. Ligament yellowish, short and very protuberant. Calcareous portion of ligament supported by short nymphal callosities. In the left valve, the cardinal complex consists of an anterior slightly thickened bifid tooth with subequal lobes and of a posterior very thin, elongate, laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior, skewed, weak bifid tooth with narrow lobes and of an anterior small, slightly thickened laminate cardinal tooth; anterior lateral tooth proximal, elongate and upcurled; posterior lateral tooth distal, pointed and socketed above. Adductor muscle scars moderately well impressed. Pallial sinus equal in both valves, rising rather abruptly behind, rounded above, gently descending, approaching very near to but not touching the anterior adductor muscle scar and falling in a smooth arcuation to the pallial line; confluence extensive. Color white to pellucid, rarely with a brownish periostracum externally, not rayed or suffused with red; internally somewhat polished.

length	height	width	
6.5 mm.	3.2 mm.	—	Syntype of <i>vespuciana</i> d'Orb.
7.5	4.5	—	La Parquera, Puerto Rico
5.6	3.3	1.7 mm.	La Parquera, Puerto Rico
5.0	3.0	1.4	Jamaica

Remarks. *Tellina vespuciana* is placed within *Eurytellina* because it conforms to the syndrome of characters exhibited by this group. It is unlike all other members of *Eurytellina* in regard to its extremely small size, and in this trait it indicates the relationship between *Eurytellina* and *Angulus*.

Tellina vespuciana is possibly closely allied to *T. nitens* for there is some sculptural similarity between the two species. In contrast to *nitens*, *vespuciana* in its maximum size is less than 10 millimeters in length, the posterior ridge of the right valve is strong, and the shell lacks any orange-apricot coloration. There does not appear to be any direct eurytellinid analog of *vespuciana* in the Eastern Pacific and it is difficult to assign any ancestral status to fossils in the Western Atlantic which resemble *vespuciana*.

Tellina vespuciana bears the closest resemblance to *T. sybaritica*. The convergence exhibited by these two species is so great as to render the subgeneric status of the species questionable. Both are similar in regard to the superficial sculpture and the configuration of the pallial sinus. *T. sybaritica* possesses an obsolete right distal posterior lateral tooth, but in its variation, this structure very closely approaches the strength of the homologous tooth in *T. vespuciana*. Typically the right posterior lateral tooth in *vespuciana* is pointed, socketed above and strong. In addition, *vespuciana* never possesses bright coloration as *sybaritica* does.

Range. This species is so poorly known that the assignment of a definite range is impossible. It is primarily Caribbean; the single record from the Gulf of Mexico, because of its fragmentary nature, is somewhat questionable.

Specimens examined. TEXAS: off Port Isabel, in 50 fathoms (MCZ). BRITISH HONDURAS: Belize and Monkey River (ANSP). GUATEMALA: Puerto Barrios and Livingston (ANSP). JAMAICA: (MCZ). HISPANIOLA. SANTO DOMINGO: Bahia de Samana, in 16–17 fathoms (USNM). PUERTO RICO: Bahia de Añasco; Mayagüez (both MCZ); La Parquera (IMBPR). LESSER ANTILLES: St. Johns, Antigua, in 30 feet (ANSP); Martinique; Gulf of Paria, Trinidad (both MCZ).

Subgenus *Angulus* Megerle von Mühlfeld

Angulus Megerle von Mühlfeld 1811, Gesellschaft Naturforschender Freunde Berlin, Magazin, 5: 47 (type species, *Tellina lanceolata* Gmelin 1791, subsequent designation, Gray 1847, p. 186).

Oulardia Monterosato 1884, Nomenclatura generica e specifica di alcune Conchiglie Mediterranee, Palermo, p. 22 (type-species, *Tellina oudardii* Payraudeau 1826 [= *T. compressa* Brocchi 1814], original designation).

Moerella 'Fischer' Gardner 1928, U.S. Geol. Sur., Prof. Paper 142-E, p. 195, *non* Fischer 1887.

Anbulus Megerle von Mühlfeld. McLean 1951, New York Acad. Sci., 17(1): 96, error for *Angulus*.

Description. Shell small to medium in size, fragile to solid, ovate to elliptical in shape, with the left valve generally more convex and with a flexure to the right posteriorly. Sculpture primarily concentric and weakly incised over the surface of the valves; rarely differentiated along the posterior dorsal slope. Hinge without lateral dentition in the left valve. Right valve with the anterior lateral tooth adjacent to the cardinal complex and with an obsolete lateral tubercle. Pallial sinus generally extensive, confluent with the pallial line for much of its ventral length.

Various interpretations have been allotted the group *Angulus*. Megerle von Mühlfeld's original discussion includes a truly heterogeneous assemblage of species with some four kinds of *Angulus* delineated. Later, when Gray (1847) designated *Tellina lanceolata* Gmelin of the Philippines as type, the content of the group was diminished. Salisbury (1934) stated that the type designation of Gray served to restrict *Angulus* to only two Recent species; however, five species bearing the name *Angulus* occur in Salisbury's illustrations. With specific reference to the fauna of North America, Gardner (1928) introduced *Moerella* Fischer to replace *Angulus* which had up to that time become widely used in the literature, and Olsson and Harbison (1953) in following the procedure outlined by Gardner have illustrated the type species of both and described *Moerella* as having 'two strong laterals in the right valve.' The problem is the interpretation of the dental structure of *Tellina donacina*, the type species of *Moerella*, and of *T. lanceolata*, the type species of *Angulus*. *Angulus* lacks any left lateral dentition, and the type species does not have a developed right posterior lateral tooth. However, a fold or slight tubercle along the posterior end of the hinge line in the right valve may be discerned. The anterior lateral tooth in the right valve is well developed, upcurled, and shelf-like. On the other hand, *Tellina donacina*, the type of *Moerella*, has a strong right posterior lateral tooth similar to that developed in *Eurytellina*. The shell is heavy and the concentric sculpture strong.

The morphology of the species in the Western Atlantic exhibits a pattern most closely expressed in *Angulus*. Not only is the right posterior lateral tooth poorly developed or

obsolete in the Western Atlantic species, but the general shell construction, in terms of thickness and sculpture, also indicates the relationship with the Indo-Pacific species.

It may be concluded that the anguloid syndrome consists of a right anterior lateral tooth adjacent to the cardinal complex and of an obsolete, absent or poorly developed right distal posterior tooth. The subgenus as herein defined is cosmopolitan in its distribution but with a primary concentration and development of species in the tropics. The group is represented as early as the Eocene in North America.

KEY TO THE SPECIES OF *ANGULUS* IN THE WESTERN ATLANTIC

1. Shell of high proportions, height more than 70% of length 2
 Shell of lower proportions, height less than 70% of length 5
2. Shell rounded or ovate in outline; not highly colored 3
 Shell subquadrate in outline; highly colored *colorata*
3. Shell with the right anterior lateral tooth subproximal to the
 cardinal complex 4
 Shell with the right anterior lateral tooth closely adjacent to the
 cardinal complex *tampaensis*
4. Pallial sinus uniting with the pallial line some distance from the
 anterior adductor muscle scar *mera*
 Pallial sinus uniting with the pallial line at or near its junction
 with the anterior adductor muscle scar *paramera*
5. Sculpture consisting of raised concentric lirations 6
 Sculpture consisting of finely incised sulci 7
6. Shell pellucid, highly colored and sharply flexed *sybaritica*
 Shell dull white and not sharply flexed *tenella*
7. Shell solid, subtrigonal and pointed behind 8
 Shell thin to subsolid and elongate-elliptical 9
8. Posterior slope sharply cleft by a radial sulcus; periostracum
 grayish-green *gibber*
 Posterior slope not cleft by a single radial sulcus; shell mostly
 red in color *exerythra*
9. Pallial sinus separated from the anterior adductor muscle scar
 by at least one millimeter 10
 Pallial sinus closely approaching the anterior adductor muscle scar,
 separated by less than one millimeter 13
10. Anterior dorsal margin nearly parallel with the ventral margin,
 distinctly separated from the anterior margin; shell vitreous . . . *euvitrea*
 Anterior dorsal margin gently inclined, somewhat convex and not
 parallel with the ventral margin 11
11. Shell greatly inflated; right posterior bifid cardinal skewed . . . *diantha*
 Shell not greatly inflated; right posterior bifid cardinal tooth not
 strongly skewed 12
12. Shell compressed; flesh-color with rays posteriorly *probrina*
 Shell not compressed; white or pink in color *agilis*
13. Sculpture along the posterior dorsal slope of the right valve
 differentiated; often rayed with pink or red posteriorly *versicolor*
 Sculpture along the posterior dorsal slope of the right valve not
 differentiated; white to pellucid yellow in color; not rayed
 posteriorly *texana*

***Tellina (Angulus) tampaensis* Conrad**

Plate 152, fig. 3; Plate 153, fig. 4

Tellina tampaensis Conrad 1866, American Jour. Conchology, 2: 281, pl. 15, fig. 8 (Tampa Bay, Florida) [syntypes, ANSP 52434].

Tellina (Angulus) tampaensis Conrad. Dall 1900, Proc. U.S. Nat. Mus., 23: 296.

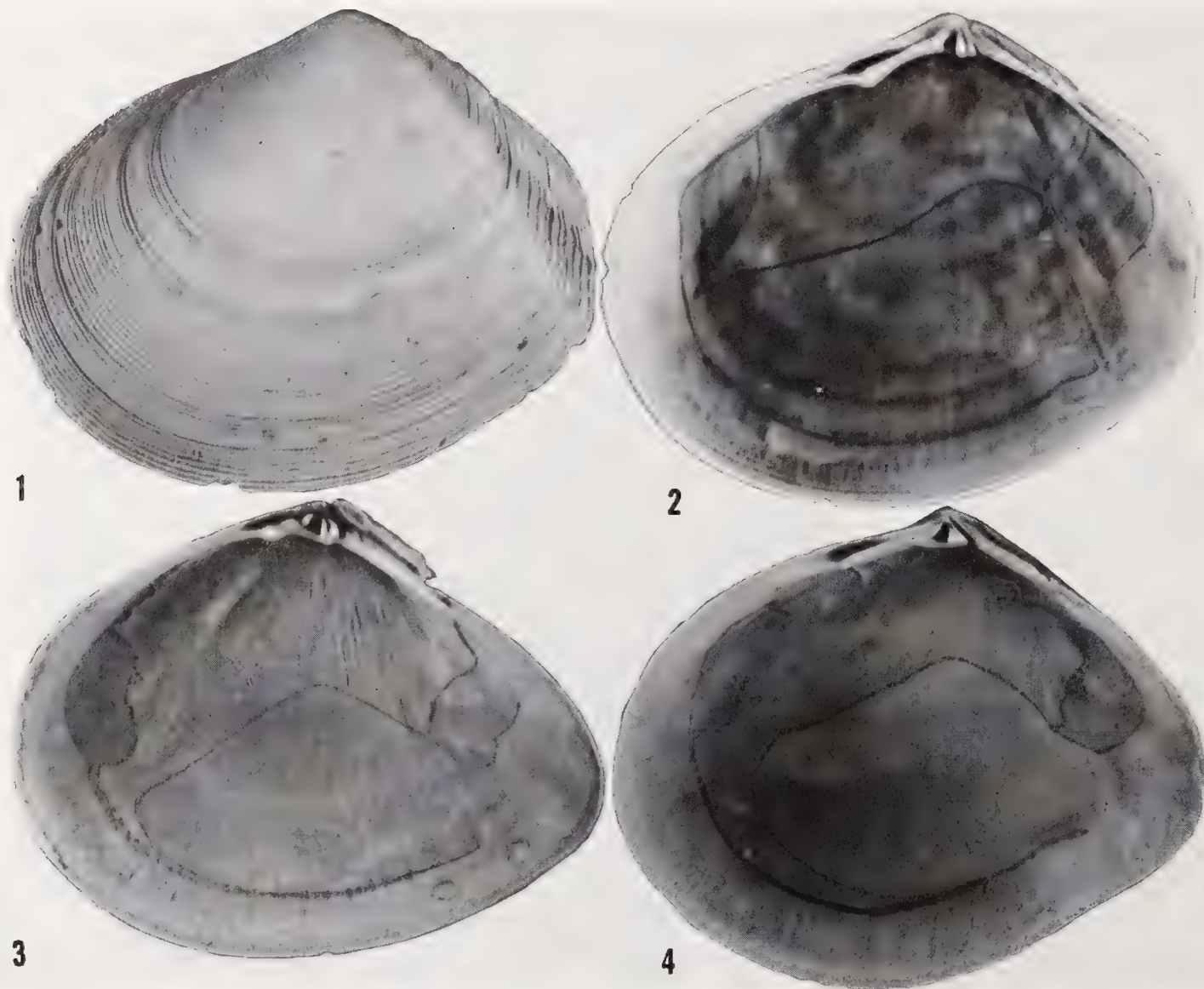


Plate 152. Figs. 1-2. *Tellina paramera* Boss. Fig. 1. External view of the left valve of the holotype. Fig. 2. Internal view of the right valve of the holotype, off Miami Beach, Florida, MCZ 242904 (about 5.6x) [L=12.5 mm.]. Fig. 3. *Tellina tampaensis* Conrad, internal view of the right valve, Tampa Bay, Florida, MCZ 59480 (about 4.2x) [L=16.5 mm.]. Fig. 4. *Tellina mera* Say, internal view of the right valve, Madera Bay, Florida, MCZ 236461 (about 4.8x) [L=15 mm.].

Description. Shell extending to 24 mm. (about 1 inch) in length and to about 18 mm. (about $\frac{3}{4}$ inch) in height, ovate-subtrigonal, produced posteriorly, with the left valve slightly more convex and with a strong posterior flexure to the right. Umbos central and pointed. Anterior margin broadly rounded; ventral margin convex and with a post-basal arcuation; anterior dorsal margin short and gently sloping; posterior dorsal margin steeply sloping; posterior margin short and slightly truncate. Sculpture consisting of concentric lirations separated by narrow, well incised sulci. Ligament brown and protuberant. Calcareous portion of the ligament well developed and subtended by weak nymphal callosities. In the left valve, the cardinal complex consists of an anterior sub-deltoid bifid tooth, the anterior lobe being the larger, and of a posterior thickened laminate

tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior skewed, subdeltoid bifid tooth with subequal lobes and of an anterior strong laminate tooth; anterior lateral tooth thin and very close to the cardinal complex; posterior lateral tooth distal and obsolete. Adductor muscle scars well impressed. Anterior adductor longer, narrower and higher than the posterior adductor. Pallial sinus generally similar in both valves, descending to the pallial line in a characteristic short, straight drop and becoming confluent with it some distance from the adductor scar. Externally, shell white, smooth, sometimes iridescent and rarely suffused with a pale peach coloration. Internally, white, shining and often chalky.

length	height	width	
24.0 mm.	18.0 mm.	8.0 mm.	Key West, Florida
18.5	13.5	6.0	Key West, Florida
16.6	17.3	5.7	Tampa Bay, Florida
14.6	11.4	5.0	Tampa Bay, Florida
11.0	9.0	4.5	Trout Bayou, Texas

Remarks. In the Western Atlantic, there are two other species which are closely related and sometimes rather easily confused with *tampaensis*. *Tellina mera* Say may be differentiated by its right anterior lateral tooth which is more distally removed from the cardinal complex than the same structure in *tampaensis*; furthermore, the pallial sinus in *mera* has only a short posterior confluence with the pallial line. *Tellina paramera* is a heavier and more thickly shelled species; its color is usually pure white and unlike the peach coloration found in *tampaensis*. The anterior lateral tooth of *paramera* though subproximal to the cardinal complex is trigonal, heavy and strong, and the pallial sinus connects directly to the pallial line just beneath the anterior adductor muscle scar.

Tellina tampaensis appears to be related to *Tellina suffusa* of the Eastern Pacific which is distinguished by its unusually large lunular area. In the Indo-Pacific, certain highly colored species, including *Tellina rutila* Dunker from Japan, are very similar to *tampaensis*.

Dall (1900b) listed this species as occurring in the Pliocene marls of the Caloosahatchie River, Florida. The species appears to prefer sandy substrates in shallow water; the maximum depth record is twenty feet.

Range. *Tellina tampaensis* is found as far north along the Atlantic coast of Florida as Mosquito Lagoon. It is found all along the Gulf coast of Florida and the southern states to Port Isabel, Texas and has been recorded from Jamaica and Haiti.

Specimens examined. FLORIDA: Mosquito Lagoon, near Haulover; Banana River; Lake Worth; Coconut Grove; Biscayne Bay; Madeira Bay (all MCZ); Key Largo; Big Pine Key (both USNM); Boca Chica Key; Key West (both ANSP); Boca Grande Key; Eagle Key; Punta Rassa; Blind Pass and Tarpon Bay, Sanibel (all MCZ); Charlotte Harbor; Useppa Island; Little Gasparilla (all MCZ); Lemon Bay; Sarasota Key; Mullet Key; Gulfport; Tampa Bay (all MCZ); St. Andrew's Bay; Pensacola (both USNM). TEXAS: Espiritu Santo Bay (ANSP); Kellers Bay; Matagorda Bay (both USNM); Trout Bayou, Rockport; Corpus Christi; Port Isabel (all MCZ). BAHAMA ISLANDS: Nassau, New Providence (ANSP). JAMAICA: Montego Bay; Old Harbor, St. Catherine (both ANSP). HISPANIOLA. HAITI: Aquin (USNM).

Tellina (Angulus) mera Say

Plate 152, fig. 4; Plate 153, fig. 1

Tellina mera Say 1834, American Conchology, **7**: pl. 64, fig. 2 (coast of South Carolina) [type locality, here corrected and restricted, Bermuda; types lost].

Tellina obtusa Sowerby 1868 [in] Reeve, Conch. Icon., **17**, *Tellina*, pl. 46, fig. 271 (Isle of St. Thomas) [holotype, BMNH], non Sowerby 1817.

Tellina (Angulus) mera Say. H. and A. Adams 1856, Genera Recent Mollusca, **2**: 397.

Tellina (Angulus) promera Dall 1900, Proc. U.S. Nat. Mus., **23**: 296, pl. 2, fig. 11 (Bermuda) [holotype, USNM 94465].

Tellina (Angulus) obtusa Sowerby. Salisbury 1934, Proc. Malac. Soc., London, **21**(2): 85, pl. 12, fig. 4.

Tellina (Angulus) guadeloupensis [sic] 'd'Orbigny' Abbott 1958, Acad. Nat. Sci., Philadelphia, Monograph 11, p. 134, pls. 5a-b, Map 8, non d'Orbigny 1842.

Description. Shell extending to 25.5 mm. (about 1 inch) in length and to 21.5 mm. (about $\frac{7}{8}$ inch) in height, subovate, sometimes produced posteriorly, thin to subsolid, inflated, with both valves of more or less equal convexity and with a short and sharp posterior flexure to the right. Umbos posterior to the middle, conspicuous and rather pointed. Anterior margin broadly rounded; ventral margin convex and rising posteriorly; anterior dorsal margin gently sloping and concave; posterior dorsal margin steeply inclined and straight; posterior margin parallel to the dorso-ventral axis and forming a blunt truncation. Concentric sculpture consisting of irregularly spaced lirations; radial sculpture weak. Ligament yellowish brown, weak and short. Calcareous portion of the ligament moderately developed; no nymphal callosities. In the left valve, the cardinal complex consists of an anterior subdeltoid bifid tooth with subequal lobes and of a posterior small and thin laminate tooth; no true laterals present. In the right valve, the cardinal complex consists of a posterior, slightly skewed and elongate bifid tooth and of an anterior subdeltoid laminate tooth; anterior lateral tooth subproximal to the cardinal complex and laminate; posterior lateral tooth absent or obsolete. Adductor muscle scars generally well impressed. Anterior adductor elongate and with irregular margins; posterior adductor small and subquadrate. Pallial sinus equal in opposite valves, rising abruptly behind, descending gently toward the anterior adductor scar, but not touching it. The sinus is broadly rounded in front and parallel to the pallial line for some distance before becoming confluent with it. Shell white, shining and rarely iridescent.

length	height	width	
14.5	11.0 mm.	6.6 mm.	Holotype of <i>obtusa</i> Sowerby
18.0	14.5	7.0	Holotype of <i>promera</i> Dall
25.5	21.0	—	New Providence, Bahamas
19.5	16.0	9.0	St. George's Island, Bermuda
12.0	10.0	5.0	Watling Island, Bahamas

Remarks. The holotype of *Tellina mera* Say which came originally from the Ravenel Collection is apparently lost; it is neither in the Academy of Natural Science, Philadelphia nor in the Charleston Museum; no original measurements were included. The type locality was given as 'the coast of South Carolina' and is erroneous; it is herein corrected to 'Bermuda', which is the type locality of one of the synonyms.

Tellina mera may be immediately distinguished from its closest relatives by the nature of the pallial sinus. This character is diagnostic and separates *T. tampaensis* and *T. paramera* from *T. mera*. The recently described *T. paramera* is the nearest relative of *mera*

in the Western Atlantic. The pallial sinus of *paramera* extends to the anterior adductor muscle scar and unites with the pallial line at the base of that scar; the confluence of the pallial sinus with the pallial line is complete and extensive. In *mera*, the sinus is confluent with the pallial line posteriorly and is not coalescent with the anterior adductor muscle scar.

Tellina mera, as presently recognized, possesses an extraordinary degree of variation. Dall proposed the specific name *promera*, which he considered to be a very close relative of *mera*. A review of specimens in major museum collections and a critical examination of Dall's types show that *promera* is a synonym of *mera*. Dall indicated that sculptural differences could separate *promera* from *mera* although the sculptural pattern might be worn away. Such an unstable trait certainly fails in the practical aspects of specific identification and can, therefore, be of little use. Some specimens possess distinct, widely spaced and strong concentric ridges whereas others, at the opposite extreme, are sculptureless, smooth and shining. The range of intermediates representing the whole continuum from sculptureless to heavily ridged may be sampled in a single population. The thickness of the shell also varies between two great extremes; some specimens are fragile and vitreous while others are heavy, solid, and chalky. In conclusion, *mera* is an extremely variable species with numerous plastic characteristics but with certain sufficiently stable, diagnostic traits which form a distinguishably valid syndrome of characters by which the species is recognized.

The Eastern Pacific analog of *Tellina mera* is *T. meropsis* Dall (= *paziana* Dall) which, according to Olsson (1961), is found from California to Ecuador.

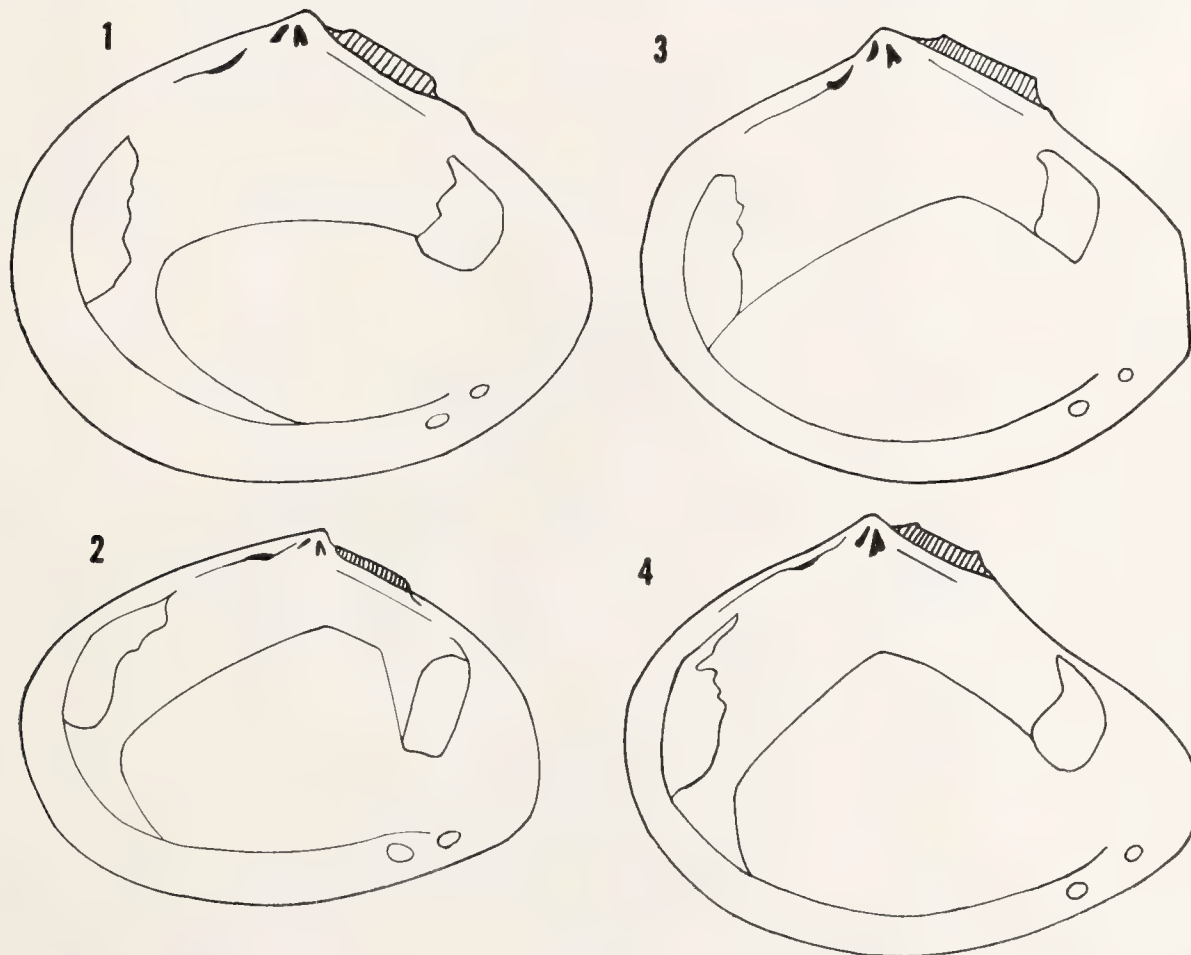


Plate 153. Figs. 1-4. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina mera* Say (about 4x) [L=15 mm.]. Fig. 2. *Tellina colorata* Dall (about 4x) [L=13 mm.]. Fig. 3. *Tellina paramera* Boss (about 4x) [L=15 mm.]. Fig. 4. *Tellina tampaeensis* Conrad (about 4x) [L=15 mm.].

Range. *Tellina mera* is found from Florida and Bermuda in the north through the Bahama Islands and the Antilles to Barbados and Curacao.

Specimens examined. FLORIDA: Lake Worth; Ocean Beach; Key Largo; Hawk Channel (all USNM); Lignum Vitae Key (ANSP); Grassy Key; Bonefish Key (both MCZ); Missouri Key; Bahia Honda Key; Sugar Loaf Key; Key West (all ANSP); Barracouda Key; Boca Grande Key; Dry Tortugas; Cape Sable (all USNM); Tarpon Bay, Sanibel; Tampa Bay; Pass-a-grille (all MCZ). BERMUDA: St. George's Island (MCZ); Harrington Sound (USNM). BAHAMA ISLANDS: Little Abaco; New Providence; Cat Island; Watling Island (all MCZ); Great Exuma (USNM). CUBA: Cabo Cajon; Dimas; Santa Lucia; Bahia Honda (all USNM); Cayo Lucas, Las Villas, La Sortiga, Cayo Caiman, and Cayo Salina, Caibarien (all MCZ). HISPANIOLA. SANTO DOMINGO: Puerto Plata; Puerto Sosua (both MCZ). PUERTO RICO: San Juan; Vieques (both USNM). VIRGIN ISLANDS: St. Thomas (ANSP). LESSER ANTILLES: Antigua; Barbados (both USNM). CARIBBEAN ISLANDS: Grand Cayman (ANSP); Curacao USNM).

***Tellina (Angulus) paramera* Boss**

Plate 152, figs. 1–2; Plate 153, fig. 3

Tellina (Angulus) paramera Boss 1964, Occ. Pap. Dept. Mollusks, Harvard University, 2: 311, pl. 55, figs. 3 and 8 (off Miami Beach, Florida, in 8½ fathoms; holotype, MCZ 242904).

Description. Shell extending to 14.5 mm. (about $\frac{5}{8}$ inch) in length and to 12.5 mm. (about $\frac{1}{2}$ inch) in height, ovate, subsolid to solid, moderately inflated with both valves of more or less equal convexity and with or without a slight posterior flexure to the right. Umbos posterior to the middle, somewhat elevated, inflated and blunt. Anterior margin broadly rounded; ventral margin convex and rising slightly posteriorly; anterior dorsal margin straight and gently sloping; posterior dorsal margin rather steeply inclined, short and slightly convex; posterior margin short and forming an irregular blunt truncation. Concentric sculpture consisting of closely set, raised ridges (about 8–10 per millimeter) separated by shallow sulci; radial sculpture consisting of poorly developed, evenly spaced lirations which more or less cover the disc. Ligament reddish brown, poorly developed, not protuberant and sunken in an elongate and narrow escutcheon; lunule poorly defined, shallow and broad. Calcareous element of the ligament moderately developed and resting on a flattened hinge plate; no true nymphal callosities. In the left valve, the cardinal complex consists of an anterior deltoid bifid tooth with subequal lobes and of a posterior elongate thickened laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior, elongate slightly skewed bifid tooth with subequal lobes and of an anterior thickened, subdeltoid laminate tooth; anterior lateral tooth large, strong, thickened and subproximal to the cardinal complex; posterior lateral absent or obsolete, consisting of a weak enlargement in the distal terminus of the hinge plate with an indented socket above. Adductor muscle scars not strongly impressed. Anterior adductor elongate and lunate; posterior scar transversely quadrate. Pallial sinus usually equal in opposite valves, rising abruptly behind, forming a rounded apex above and descending gently to the pallial line below; confluence entire. The pallial sinus generally does not coalesce with the anterior adductor scar but unites with the pallial line just before the anterior adductor scar. Externally, the shell is dull

white; internally, shining, not highly polished and tending to become chalky; the internal surface often possesses radial vermiculations which reflect the external radial sculpture.

length	height	width	
12.5 mm.	10.0 mm.	5.2 mm.	Holotype of <i>paramera</i> Boss
14.5	12.5	6.5	'Florida Keys'
10.3	8.4	4.3	off Miami, Florida
9.2	7.2	—	off Miami, Florida
6.2	4.5	—	off Miami, Florida

Remarks. This species may be most easily confused with *Tellina mera*, its nearest ally in the fauna of the Western Atlantic. The similarity in shape and color combined with the morphological similarities of the hinge line serve to indicate the close relationship of *mera* and *paramera*. In the latter, however, the shell is noticeably thicker and heavier and, in addition, the posterior margin forms a diagnostic blunt truncation. The configuration of the pallial sinus distinguishes *paramera* from its relatives. In *mera*, the sinus, though extending toward the anterior adductor muscle scar, is separated from it; the sinus then parallels the pallial line for some distance of its ventral length before it falls and unites with it so that the confluence is relatively short. In *paramera*, the pallial sinus is closely aligned to the anterior adductor muscle scar, if not contiguous with it, and the confluence of the pallial sinus with the pallial line is virtually complete, extending the entire ventral length of the pallial line.

Tellina paramera occurs from the shore line to depths of fifty fathoms. Since specimens are relatively rare and the species remained unrecognized until recently, it may be postulated that an offshore habitat in moderate depths is preferred. An analog of *Tellina paramera* does not seem to be recorded for the Eastern Pacific.

Range. The species occurs from Bermuda, through the Bahama Islands and off the coast of southeastern Florida to the Barbados, Lesser Antilles.

Specimens examined. FLORIDA: off Miami Beach, in 6–30 fathoms; off Bear's Cut, Miami, in 18–20 fathoms; off Government Cut, in 3–38 fathoms; off Bell Buoy, Miami, in 15–22 fathoms; off Fowey Light, in 22–40 fathoms; Bird Key, Biscayne Bay, in 2–10 feet (all USNM); off American Shoals, in 45 fathoms (MCZ); Key West; Tortugas, in 15 fathoms (both USNM). BERMUDA: Ferry Point, St. George's Island (USNM). BAHAMA ISLANDS: Grand Bahama (USNM); Thompson's Bay, Long Island (MCZ). CUBA: Cape Cajon; Cayo Levisa; Bahia Honda, in 1–12 fathoms (all USNM). HISPANIOLA. SANTO DOMINGO: Puerto Sosua (MCZ). LESSER ANTILLES: off Payne's Bay Church, in 50 fathoms, and Carlisle Bay, in 6 fathoms, Barbados (both USNM).

Tellina (Angulus) colorata Dall

Plate 153, fig. 2; Plate 155, fig. 2

Tellina tenuis 'da Costa' Say 1834, American Conchology, pt. 7, pl. 64, fig. 3.

Tellina omoia Ravenel 1886, Proc. Elliot Soc., 2(5): 38 (Sullivan's Island, South Carolina) [type lost; *nomen oblitum*].

Tellina (Angulus) colorata Dall 1900, Proc. U.S. Nat. Mus., 23: 313, pl. 2, fig. 9 (Guadeloupe, Lesser Antilles) [holotype, USNM 42865].

Description. Shell extending to 19.5 mm. (about $\frac{3}{4}$ inch) in length and to 13 mm. (about $\frac{1}{2}$ inch) in height, thin, subquadrate, compressed with the valves of equal convexity and with a weak posterior flexure to the right. Umbos nearly central, small and pointed. Anterior margin narrowly to broadly rounded; ventral margin convex and rising

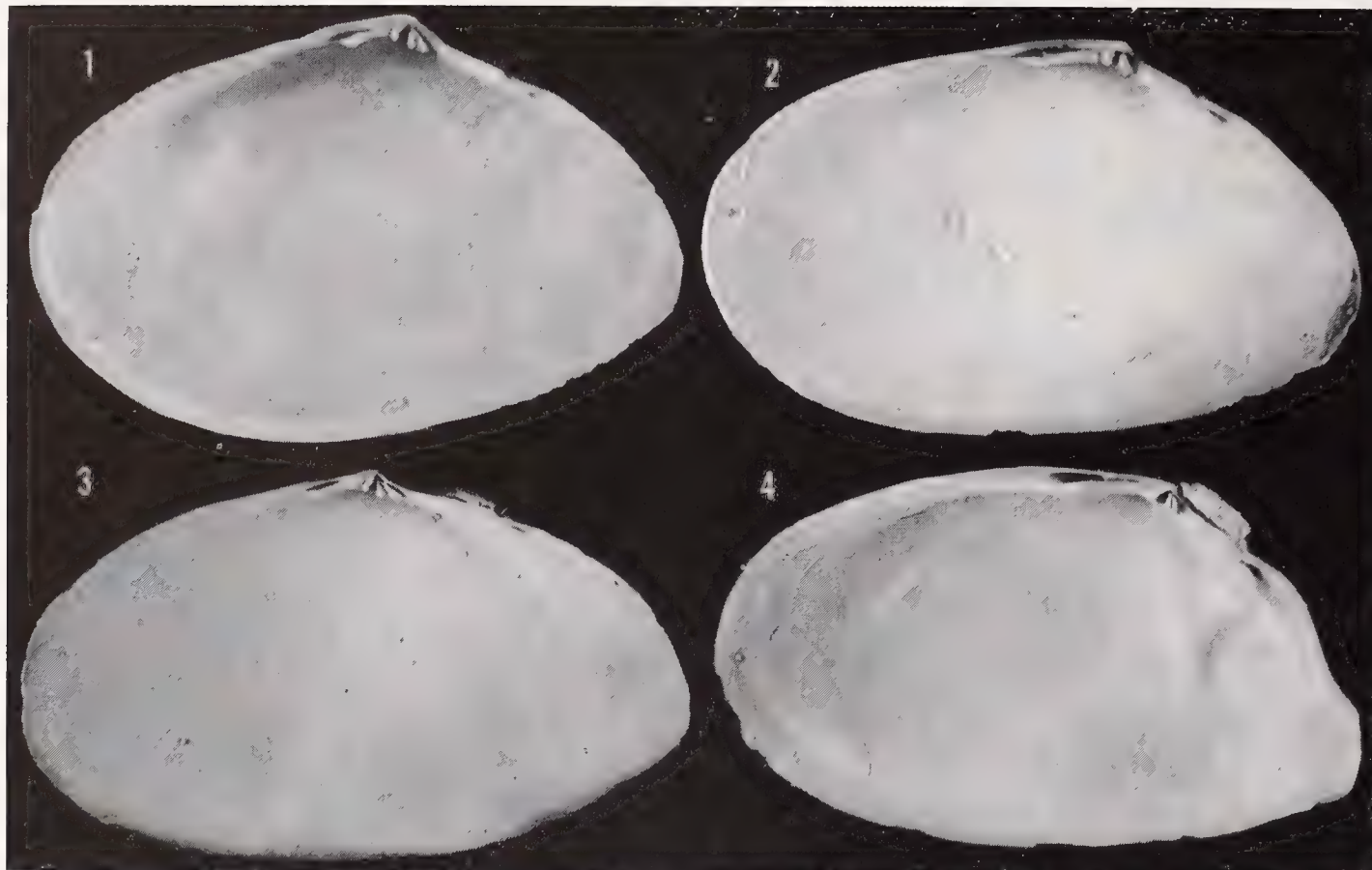


Plate 154. Fig. 1. *Tellina agilis* Stimpson, internal view of the right valve, Revere, Massachusetts, MCZ 230574 (about 4.7x) [L=15 mm.]. Fig. 2. *Tellina texana* Dall, internal view of the right valve, Sanibel Island, Florida, MCZ 53395 (about 6x) [L=12 mm.]. Fig. 3. *Tellina diantha* Boss, internal view of the right valve of the holotype, Barbados, West Indies, MCZ 239110 (about 2.7x) [L=26.5 mm.]. Fig. 4. *Tellina gibber* von Ihering, internal view of the right valve, Puerto Quequen, Argentina, MCZ 118678 (about 4.3x) [L=16 mm.].

gently posteriorly; anterior dorsal margin long, slightly convex and gently descending; posterior margin forming an oblique truncation. Sculpture consisting of poorly defined, closely set concentric lirations; weak radial lirations also evident. Ligament short, brown and protuberant. Calcareous portion of the ligament well developed and subtended by extremely well developed nymphal callosities. In the left valve, the cardinal complex consists of an anterior subdeltoid bifid tooth with subequal lobes and of a posterior divergent, thin laminate tooth; no true lateral teeth. In the right valve, the cardinal complex consists of a posterior protuberant bifid tooth and of an anterior thickened laminate tooth; anterior lateral tooth immediately proximal to the cardinal complex, thin and laminate; posterior lateral tooth absent or obsolete. Adductor muscle scars well impressed. Anterior adductor narrowly lunate; posterior adductor elongate and quadrate. Pallial sinus more or less equal in opposite valves rising abruptly posteriorly, gently rounded above, well separated from the anterior adductor scar and arcuately descending to unite with the pallial line below; confluence extensive. Externally and internally the shell is smooth and shining, transparent, white and often suffused with apricot, yellow, orange or red.

length	height	width	
19.5 mm.	13.0 mm.	5.0 mm.	Florida
15.5	11.5	4.0	St. Thomas, Virgin Islands
13.5	9.5	3.8	Guadeloupe, Lesser Antilles

Remarks. This species appears to be very rare and is sporadically dispersed in the Western Atlantic. It does not appear to have an Eastern Pacific analog and is most closely allied to *Tellina tenuis* da Costa of Europe. The similarities between these species are so great and the documentation of living records for *colorata* so poor that some question as to the existence of *colorata* is not unfounded. However, herein *colorata* will be accorded full specific rank until further evidence to the contrary is available. *Tellina colorata* possesses slightly different proportions, being higher and more quadrate with the ventral margin less convex and arcuated than *tenuis*. In addition, the nymphal callosities of *colorata* are more strongly developed, thicker and more protuberant.

Range and specimens examined. Only two lots with specific locality data were available: St. Thomas, Virgin Islands and Guadeloupe, Lesser Antilles (USNM). A lot from Florida (MCZ) is questionable, and specimens from South Carolina are not to be found. At this time no definite range can be stated.

Tellina (Angulus) agilis Stimpson

Plate 154, fig. 1; Plate 157, fig. 2

Tellina tenera Say 1822, Jour. Acad. Nat. Sci., Philadelphia, **2**: 303 (inhabits the coast of New Jersey. . . Great Egg Harbor) [syntypes, ANSP 52446], *non* Schrank 1803.

Tellina elucens Mighels 1844 [*teste* Dall 1900], Proc. Boston Soc. Nat. Hist., **1**: 188 (Casco Bay, Maine) [holotype lost; *nomen dubium*].

Tellina (Angulus) tenera Say. H. and A. Adams 1856, Genera Recent Mollusca, **2**: 398.

Tellina agilis Stimpson 1857, Amer. Jour. Sci., **25**: 125, new name for *tenera* Say.

Angulus tener Say. Verrill 1872, Amer. Jour. Sci., **3**: 290, pl. 6, 1-1a.

Description. Shell extending to 16 mm. (about $\frac{5}{8}$ inch) in length and to 10 mm. (about $\frac{3}{8}$ inch) in height, elongate-subquadrate, rather fragile, somewhat compressed with the valves of more or less equal convexity and with a slight posterior flexure to the right. Umbos posterior to the middle, small and blunt. Anterior margin narrowly rounded; ventral margin gently convex and rising posteriorly; anterior dorsal margin elongate and gently inclined; posterior dorsal margin steeply inclined and short; posterior margin irregular and forming a weakly rounded oblique truncation. Sculpture consisting of weakly incised very closely spaced concentric sulci, imposed on broad growth bands; no true radial sculpture present. Ligament dark yellowish brown, short and slightly protuberant. Calcareous portion of the ligament subtended by weak nymphal callosities. In the left valve, the cardinal complex consists of an anterior subdeltoid bifid tooth with equal lobes and of a posterior thin and elongate laminate tooth; no true lateral teeth. In the right valve, the cardinal complex consists of a posterior, skewed, subdeltoid bifid tooth whose posterior lobe is the larger and of an anterior, thickened laminate tooth; anterior lateral tooth proximal, thickened and often upcurled; posterior lateral tooth distal, weak and obsolete. Adductor muscle scars generally well impressed. Anterior adductor elongate and rounded below; posterior adductor rounded. Pallial sinus more

or less equal in opposite valves, arched above, falling with a gentle slope to the pallial line and separated from the anterior adductor. Shell generally white, but rarely suffused with pink or red; interior of valves generally not shining, but of a dull powdery lustre.

length	height	width	
16.1 mm.	9.3 mm.	3.2 mm.	Revere, Massachusetts
16.0	10.6	4.7	“ “
13.3	8.4	3.9	“ “
10.5	5.6	2.4	Westerly, Rhode Island
4.5	2.8	1.2	Duxbury, Massachusetts

Remarks. *Tellina agilis* is the northernmost representative of the genus in the Western Atlantic, being the only species of *Tellina* found north of Cape Cod, Massachusetts. The species possesses an extreme range of variation. Immature specimens from one to five millimeters in size tend to be elongate while the proportions in adults are more subquadrate. The color of the shell is nearly always white, but red and pink colored individuals do occur and the color may be concentrated in bands or concentric areas on the valves.

Tellina agilis is replaced by another common species, *Tellina texana*, in the south, although there is some overlap in their ranges. From *texana*, *agilis* may be distinguished by its thinner valves, its greater compression and its disposition of the pallial sinus. In *agilis*, the pallial sinus is impressed and removed from the anterior adductor muscle scar whereas in *texana*, the sinus is less well impressed, generally not as highly arched, and closer to, but not coextensive with the anterior adductor muscle scar. The umbonal sculpture of *texana* is sharp, distinct and slightly intercalated posteriorly, that of *agilis* is smooth, tending to be worn and not intercalated.

Another species related to *Tellina agilis* and often confused with it is *Tellina tenella* Verrill, which because of its rarity has scarcely been documented in the literature. Johnson (1932) has discussed in some detail the traits which separate *tenella* from *agilis*. The outline of *tenella* is distinguished by its narrowly rounded anterior margin, convexly truncate posterior margin and its elongate, slightly concave anterior dorsal margin. Although the umbos are more highly elevated, the general proportions of *tenella* are lower than those of *agilis*. The sculpture in *tenella* consists of lirations separated by well incised sulci which are quite broadly spaced whereas the sculpture of *agilis* consists of very weak, obsolete, closely spaced and fine sulci.

Macoma phenax Dall closely approaches the shape and smooth sculpture of *agilis*, but the former is distinguished by its lack of lateral dentition.

Range. This species is found along the eastern coast of North America from the Gulf of St. Lawrence in the north to Sapelo Island, Georgia in the south.

Specimens examined. CANADA: Gulf of St. Lawrence, in 40–45 meters (USNM); North Ingoish, Cape Breton Island; Ellerslie and Bideford River, Prince Edward Island; Pugwash and East Jeddore, Nova Scotia (all MCZ); Barrington and Three Fathoms Harbour, Nova Scotia (both CNM). MAINE: Quahog Bay; Cushing (both MCZ); Casco Bay; Scarboro (both USNM); Old Orchard (ANSP). MASSACHUSETTS: Ipswich; Annisquam; Danvers; Salem; Marblehead; King's Beach, Swampscott; Lynn Beach; Nahant; Revere; Chelsea (all MCZ); Cohasset; Sam Winsor's Flat, Duxbury (both USNM); Plymouth, in 2–3 fathoms; Provincetown; Georges Bank (all USNM); South

Harwich Beach; Dennisport (both MCZ); Woods Hole; The Gutters, Naushon (both USNM); Five Fingered Point, Eel Point, East Jetty and Wyers Point, Nantucket; Katama Bay, Martha's Vineyard (all MCZ); S of Gay Head; N of Noman's Land; Buzzards Bay (all USNM); Swifts Beach, Wareham; New Bedford; Horseneck Beach (all MCZ). RHODE ISLAND: off Sakonnet, in 5 fathoms; off Newport, in 13 fathoms; Narraganset Bay; Canonicut Island (all USNM); Quonocontave Pond; Noyes Beach (both MCZ); Westerly (USNM). CONNECTICUT: Stonington; Noank (both USNM); Branford (MCZ). NEW YORK: Orient, Peconic Bay and Saybrook, Long Island (all USNM); Far Rockaway Bay, Great South Bay, Point o' Woods, Fire Island Beach and Cold Spring Harbor, Long Island (all MCZ); NEW JERSEY: Point Pleasant; Atlantic City; Norbury's Landing; Holgate, Ocean City; Wildwood (all ANSP); Cape May (CM). DELAWARE: Brandywine Shoal, Old Bare Shoal, Prime Hook Creek, Brown Shoal and Broadkill Creek, Delaware Bay; off Henlopen, in 25 fathoms; 8 miles E of Rehoboth, in 17 fathoms (all USNM). MARYLAND: Plum Point (MCZ); Crisfield; Chesapeake Bay (both USNM). VIRGINIA: Chincoteague (USNM). NORTH CAROLINA: off New Bern (USNM); Smiths Island, Cape Fear (ANSP). SOUTH CAROLINA: Isle of Palms; Folly Island (both CM). GEORGIA: Deboy Channel, Sapelo Island (MCZ).

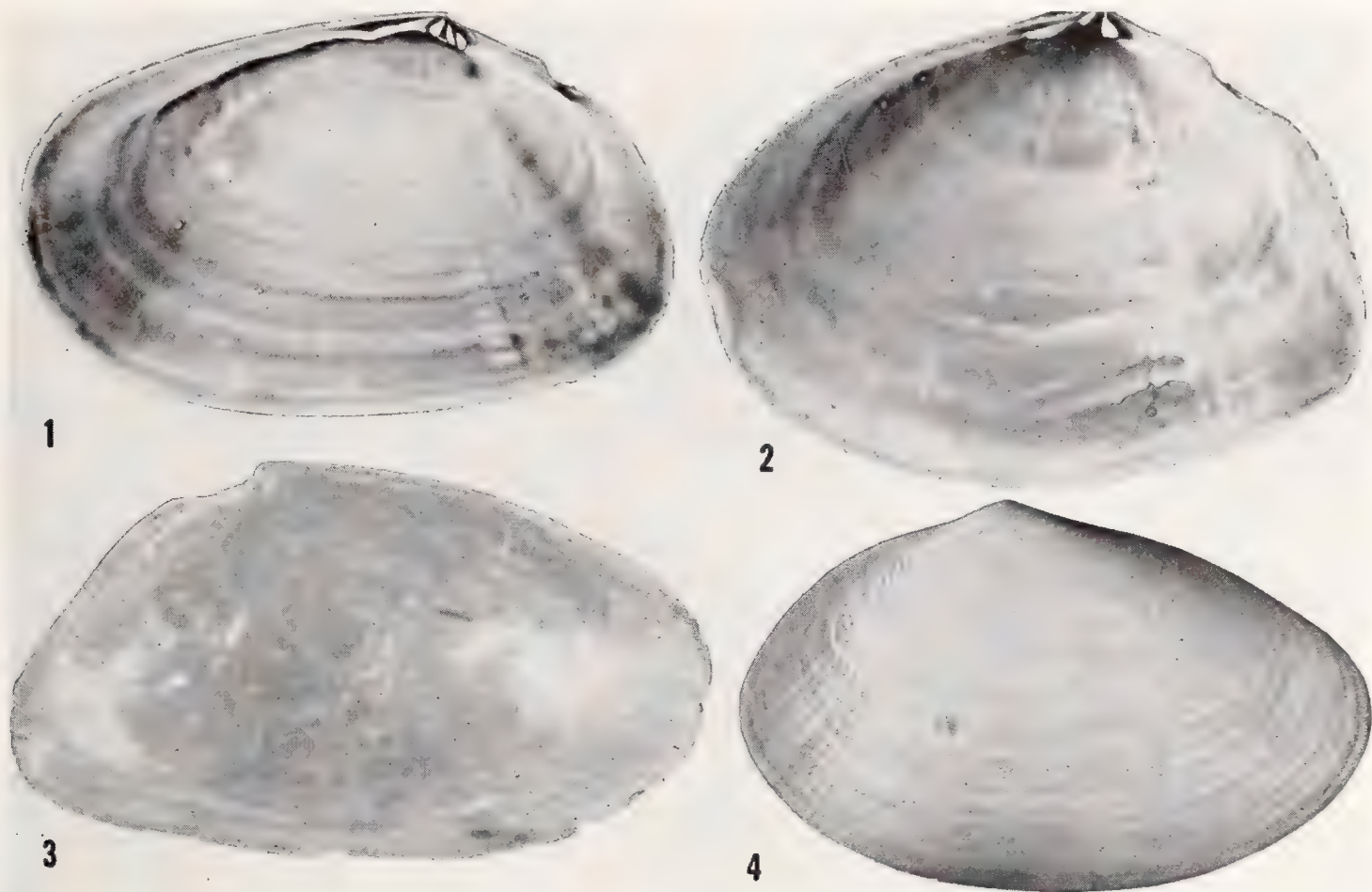


Plate 155. Fig. 1. *Tellina probrina* Boss, internal view of the right valve of the holotype, off Fowey Light, Florida, USNM 461905 (about 4x) [L=18.5 mm.]. Fig. 2. *Tellina colorata* Dall, internal view of the right valve, 'Florida', MCZ 239111 (about 4.8x) [L=15 mm.]. Fig. 3. *Tellina pauperata* d'Orbigny [= *Tellina versicolor* DeKay], external view of the right valve of a paratype, Martinique, BMNH (about 13x) [L=5.8 mm.]. Fig. 4. *Tellina americana* Dall, external view of the right valve, Lantana, Florida, MCZ 208587 (about 10x) [L=6.9 mm.].

Tellina (Angulus) texana Dall

Plate 154, fig. 2; Plate 157, fig. 6

Tellina polita Say 1822, Jour. Acad. Nat. Sci., Philadelphia, 2: 276; 1834, American Conchology, pt 7, pl. 65 fig. 2 (inhabits the southern coast . . . South Carolina and N. Florida) [type locality, here restricted, Charleston, South Carolina; syntypes, ANSP], *non* Poli 1795, *nec* Spengler 1798, *nec* Pulteney 1799.

Angulus polita Say. H. and A. Adams 1856, Genera Recent Mollusca, 2: 398.

Tellina (Angulus) texana Dall 1900, Proc. U.S. Nat. Mus., 23: 295 (Charlotte Harbor, Florida) [holotype, USNM 125539].

Tellina (Angulus) sayi 'Deshayes MS' Dall 1900, Trans. Wagner Free Inst. Sci., Philadelphia, 3(5): 1034, new name for *Tellina polita* Say.

Description. Shell extending to 16.5 mm. (about $\frac{5}{8}$ inch) in length and to 9 mm. (about $\frac{3}{8}$ inch) in height, subelliptical to subtrigonal, rather solid, inflated with both valves of equal convexity and with a sharp posterior flexure to the right. Umbos posterior to the middle and blunt. Anterior margin somewhat narrowly rounded; ventral margin straight to convex and rising posteriorly; anterior dorsal margin elongate and gently descending; posterior dorsal margin very elongate and steeply inclined; posterior margin short and forming a blunt end. Sculpture consisting of weak, finely incised, closely spaced concentric sulci; no true radial sculpture. Ligament yellowish brown, strong and protuberant. Calcareous portion of the ligament subtended by protuberant nymphal callosities. In the left valve, the cardinal complex consists of an anterior thickened bifid tooth with subequal lobes and of an elongate posterior laminate tooth; no true lateral teeth. In the right valve, the cardinal complex consists of a posterior skewed thickened bifid tooth with subequal lobes and of an anterior slightly thickened, short, laminate tooth; anterior lateral tooth proximal, thin and slightly upcurled; posterior lateral tooth obsolete and distal. Adductor muscle scars fairly well impressed. Anterior adductor scar elongate and rounded below; posterior adductor scar rounded. Pallial sinus more or less equal in opposite valves, generally convex above, gently inclined and somewhat concave anteriorly and falling arcuately to the pallial line close to but not touching the anterior adductor scar. Shell generally white, sometimes with yellow suffusions. Some iridescence externally and generally highly polished internally.

length	height	width	
16.5 mm.	9.3 mm.	4.8 mm.	Sea Island, Georgia
13.2	7.5	4.2	Port St. Joe, Florida
12.6	6.9	3.8	Grassy Key, Florida
9.8	5.8	3.0	Port Aransas, Texas
6.2	3.6	1.7	Missouri Key, Florida

Remarks. *Tellina texana* is most closely related to *Tellina agilis* and replaces it along the Atlantic coast of the southeastern states and in the Gulf of Mexico. The range of variation possessed by *texana* is similar in some respects to that of *agilis*. Of the differences which separate *agilis* from *texana*, many have been discussed previously. In *texana*, the valves are more convex, thicker and heavier, the pallial sinus approaches the anterior adductor muscle scar much more closely, and the umbonal sculpture is slightly intercalated. For more extensive comparison of these two species, see *Remarks* under *agilis*.

According to Dall (1900b), *Tellina (Angulus) declivis* Conrad from the Lower Miocene of Shiloh, New Jersey is very close to *texana*, but the Recent species has a more ventricose shell and the right anterior lateral tooth is longer than in the fossil. Dall also

documented the occurrence of *declivis* in the Upper Miocene of Virginia and the Pliocene and Pleistocene of Florida. Richards (1962) has given the Pleistocene records of *T. texana* in North and South Carolina.

Range. This species occurs from North Carolina south through the Bahamas, Florida Keys to Cuba and in the Gulf of Mexico to Progreso, Yucatan.

Specimens examined. NORTH CAROLINA: Beaufort; Pirens Island (both USNM). SOUTH CAROLINA: Isle of Palms; Sullivan's Island (both CM); off Charleston (MCZ); Morris Island (CM); Black Bear Island (MCZ); Porcher's Creek, Porcher's Bluff (CM). GEORGIA: Sea Isle (MCZ); Cumberland Island (CM). FLORIDA: St. Johns River (ANSP); St. Augustine; Palm Beach (both USNM); South Inlet, Lake Worth; Hillsboro Light (both MCZ); Ocean Beach (USNM); Coconut Grove (MCZ); off Miami, in 10 fathoms; SE of Fowey Light, in 25 fathoms (both USNM); Virginia Key (MCZ); Bird Key (USNM); Cards Sound (ANSP); off Caesar's Creek Bank, in 110 feet; off Hawk Channel, in 2-4 fathoms (both USNM); Grassy Key; Missouri Key (both MCZ); Newfound Harbor Key (USNM); Boca Chica Key (MCZ); Key West (USNM); Madeira Bay (MCZ); Marco Island; Bunch Beach (both D. and N. Schmidt); Tarpon Bay and Blind Pass, Sanibel; Punta Gorda (all MCZ); Lemon Bay; Sarasota Bay; Tampa Bay; Gulfport (all ANSP); Pine Island USNM); Seahorse Key and Goose Cove, Cedar Keys; Port St. Joe (all MCZ). TEXAS: Corpus Christi Bay (USNM); off Port Aransas, in 12 fathoms (MCZ). MEXICO: Progreso (ANSP). BAHAMA ISLANDS: North side of Abaco (USNM). CUBA: Bahia Honda, in 1-12 fathoms (USNM).

***Tellina (Angulus) versicolor* 'Cozzens' DeKay**

Plate 155, fig. 3; Plate 156, figs. 1-2; Plate 159, fig. 1

Tellina versicolor Cozzens 1836 [*in*] Jay, Catalog of Shells, 2nd Ed., p. 15 (New York), *nomen nudum*.

Tellina pauperata d'Orbigny 1842 [*in*] Sagra, Hist. L'Ile Cuba, Atlas, pl. 26, figs. 18-20; 1845, Spanish Text, 2(5): 306 (Guadalupe y Martinica); 1853, French Text, Mollusques, 2: 255 [type locality, here restricted, Martinique; holotype, BMNH 54.10.4.510], *nomen oblitum*.

Tellina versicolor 'Cozzens' DeKay 1843, Nat. Hist. New York, Pt. 1, Zoology, p. 209, pl. 26, fig. 172 (Hudson River at Glass-house Point, New York) [type lost].

Tellina (Angulus) versicolor 'Cozzens' DeKay. Dall 1900, Proc. U.S. Nat. Mus., 23: 295.

Tellina (Angulus) pauperata d'Orbigny. Dall 1900, Proc. U.S. Nat. Mus., 23: 296.

Description. Shell extending to 17.5 mm. (about $\frac{5}{8}$ inch) in length and to 9 mm. (about $\frac{3}{8}$ inch) in height, elongate, subelliptical, generally thin to fragile, moderately inflated, with both valves of nearly equal convexity and with a posterior flexure to the right. Umbos just posterior to the middle, depressed and pointed. Anterior margin narrowly rounded; ventral margin straight and rising slightly posteriorly; anterior dorsal margin elongate and gently inclined; posterior dorsal margin generally steeply inclined, short and slightly concave; posterior margin long, with a biangulation basally and forming a blunt oblique truncation. Sculpture consisting of widely spaced, strongly incised concentric sulci; no true radial sculpture. Ligament yellowish brown, short, protuberant and subtended by moderately developed nymphal callosities. In the left valve, the cardinal complex consists of an anterior, narrowly elongate bifid tooth and of a posterior thin laminate tooth; no true lateral teeth evident. In the right valve, the cardinal com-

plex consists of a posterior skewed bifid tooth with subequal lobes and of an anterior subdeltoid laminate tooth; the proximal anterior lateral tooth is relatively thin, elongate and upcurled; a weak distal vestige of the posterior lateral tooth is sometimes evident. Adductor muscle scars moderately impressed. Anterior adductor scar elongate and rounded below; posterior adductor scar rounded. Pallial sinus more or less equal in both valves, gently rising posteriorly, convex above and descending arcuately to a fusion with the pallial line below. The sinus comes very close to and sometimes is coextensive with the anterior adductor muscle scar. Color from white to red, translucent to transparent, with variously developed red, pink or white rays which extend radially from the umbo to the postbasal biangulation along the posterior slope. External surface generally shining and iridescent; internal surface polished.

length	height	width	
17.5 mm.	9.0 mm.	—	Santa Rosa, Cuba
13.5	7.5	3.4	Alligator Harbor, Florida
11.0	6.1	3.2	Santa Rosa, Cuba
9.7	5.5	2.1	Chesapeake Bay
6.0	3.0	—	Cape Hatteras, North Carolina

Remarks. The types of *Tellina versicolor* are apparently lost. *Tellina pauperata* d'Orbigny is synonymized herein because its characteristics grade into those of *T. versicolor*. The types of *pauperata* are typically white and pellucid, the posterior slope is very broadly and obliquely truncate, and the posterior dorsal margin is short and strongly concave. Specimens which fit this description occur in populations of *T. versicolor*. In accordance with Article 23b of the Internature Code, *pauperata* is considered as a *nomen oblitum*, or a forgotten name, and *versicolor*, which has been widely used in the literature, is preserved.

The distinguishing characters possessed by *Tellina versicolor* include: 1) its relatively thin, fragile shell; 2) its evenly spaced, incised concentric sculpture with a differentiated area on the posterior slope of the right valve being stronger and nearly lamellose; and 3) its pallial sinus which approaches the anterior adductor muscle scar so closely that at times it appears coextensive with it. Earlier authors considered *T. versicolor* as a species closely related to *T. consobrina*, and the latter was often considered the southern subspecies of the former. However, *Tellina consobrina* possesses a pattern of sculpture which allies it with *Scissula* and it may therefore be quickly separated from *versicolor*. Closely allied to *versicolor* via the placement of the pallial sinus and the thin, fragile nature of the valves is *Tellina probrina* which may be distinguished by its lateral compression, higher, more quadrate proportions and its lack of differentiated posterior slope sculpture.

The species most closely related to *Tellina versicolor* appears to be *T. exerythra*. The characters which identify and distinguish *T. exerythra* as an entity distinct from *T. versicolor* are difficult, if not impossible to quantify, especially at the extremes of variation where overlap occurs and where individual specimens are difficult to place. *Tellina exerythra* is subtrigonal with a thicker shell and higher proportions than *versicolor*. Most specimens of *exerythra* are bright red in color with white peripheral areas. The nature of the pallial sinus, the iridescence of the exterior surface of the valves, the slightly differentiated sculpture of the posterior slope, the incised concentric sculpture on the disc and the presence of red coloration are all traits which indicate the close relationship between *versicolor* and *exerythra*.

Range. This species is found from south of Cape Cod to Trinidad; it occurs in the Gulf of Mexico along the coast of Florida to west Texas.

Specimens examined. RHODE ISLAND: Sakonnet (MCZ). VIRGINIA: Chesapeake Bay, in 3–9 fathoms (USNM). NORTH CAROLINA: off Cape Hatteras, in 14–48 fathoms; off Cape Lookout, in 18–31 fathoms; Beaufort, in 6–9 fathoms (all USNM). SOUTH CAROLINA: Charleston Harbor (CM). FLORIDA: Banana River; South and North Inlet, Lake Worth; Coconut Grove; Virginia Key; Card Sound; off Elbow, Key Largo; Sombrero Key; Key West; Sand Key; Boca Grande Key (all MCZ); Dry Tortugas (USNM); Marco Island; Punta Rassa (both D. and N. Schmidt); Sanibel; Charlotte Harbor; Sarasota Bay, in 13 fathoms; Bradenton Beach; Gulfport (all MCZ); Sea Horse Key, Cedar Keys; Alligator Harbor (all MCZ); St. Joseph Bay (ANSP); Port St. Joe; Beacon Hill; off Destin, in 14 fathoms; off Fort Walton, in 21 fathoms (all MCZ); Indian Pass, Apalachicola Bay (ANSP). MISSISSIPPI: Horn Island (ANSP). LOUISIANA: Chandeleur Island; Barataria Bay, Grand Isle (both MCZ). TEXAS: Pass Cabello, Matagorda (USNM); off Port Aransas, in 10 fathoms (MCZ). MEXICO: off Cabo Catoche, Yucatan, in 25 fathoms (MCZ). PANAMA: Mount Hope, Pleistocene (ANSP); Bocas del Toro (Olsson). CUBA: Cape Cajon; Punta Tolete, in 2–3 fathoms; Punta Colorado, in 2–3 fathoms; Dimas, in 4–5 fathoms; Santa Rosa, in 3–6 fathoms; Santa Lucia, in 2–4 fathoms; Esperanza, in 2–3 fathoms; Cayo Arenas, in 2 fathoms; Bahia Honda, in 1–12 fathoms; Cabanas, in 3–12 fathoms (all USNM); Buena Vista Bay, Caibarien (MCZ). JAMAICA: Green Island Harbor; Montego Bay; Portland; Little Goat Island, Portland Bight (all USNM). HISPANIOLA. HAITI: Port au Prince; Les

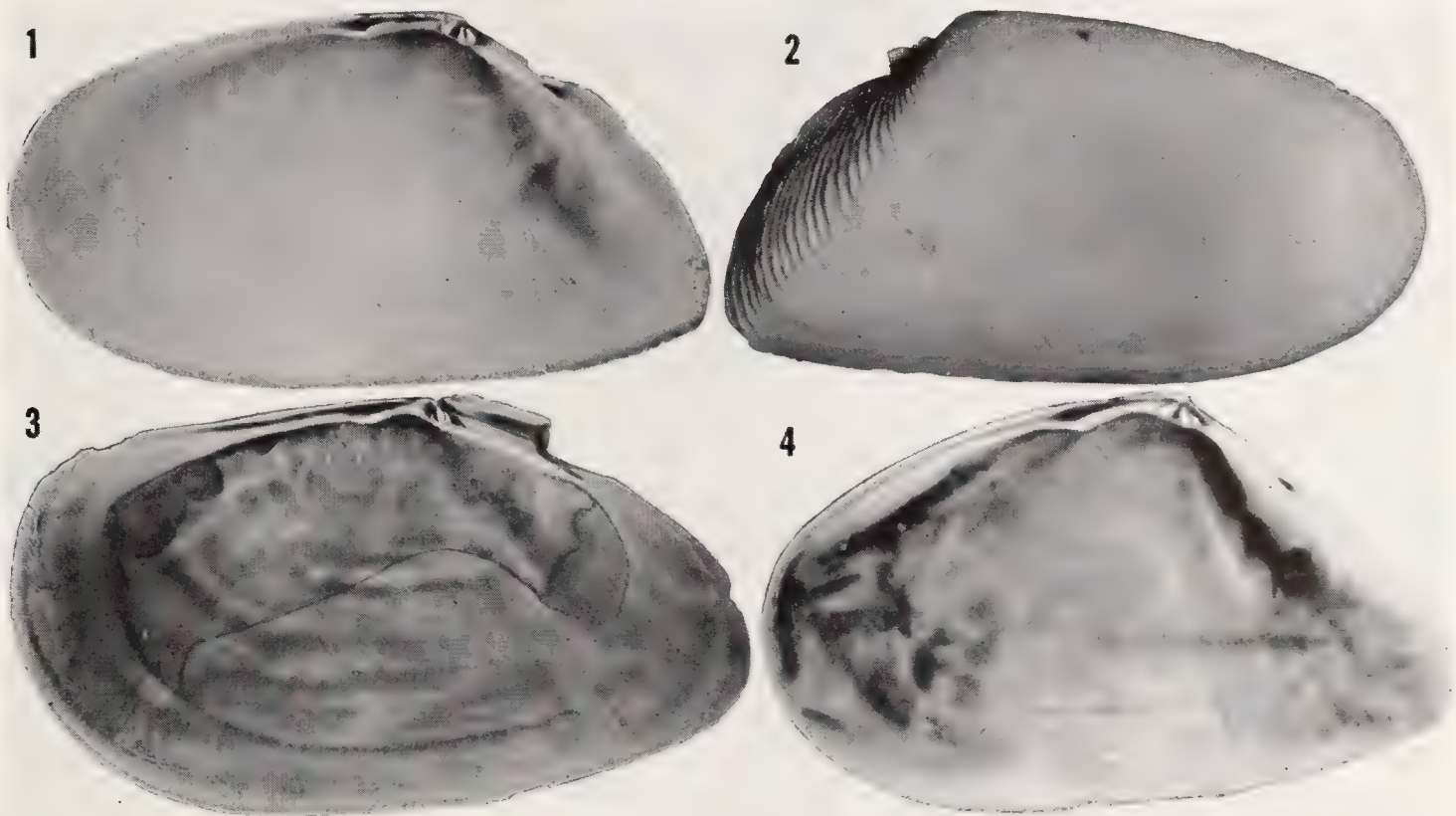


Plate 156. Figs. 1–2. *Tellina versicolor* DeKay. Fig. 1. Internal view of the right valve. Fig. 2. External view of the right valve, Destin, Florida, MCZ 239113 (about 6x) [L=12 mm.]. Fig. 3. *Tellina ewitrea* Boss, internal view of the right valve of the holotype, Santa Lucia, Cuba, USNM 461952 (about 3.8x) [L=20.5 mm.]. Fig. 4. *Tellina exerythra* Boss, internal view of the right valve of the holotype, Boca del Infierno, Bahia de Samana, Santo Domingo, MCZ 239220 (about 6x) [L=12 mm.].

Cayes (both USNM). SANTO DOMINGO: Puerta Plata (MCZ); Samana Bay, in 17–18 fathoms (USNM). VIRGIN ISLANDS: Charlotte Amelie, St. Thomas, in 30 feet (ANSP). LESSER ANTILLES: Falmouth Harbor and English Harbor, Antigua, in 3–6 fathoms; Barbados (both USNM); Gulf of Paria, Trinidad (MCZ).

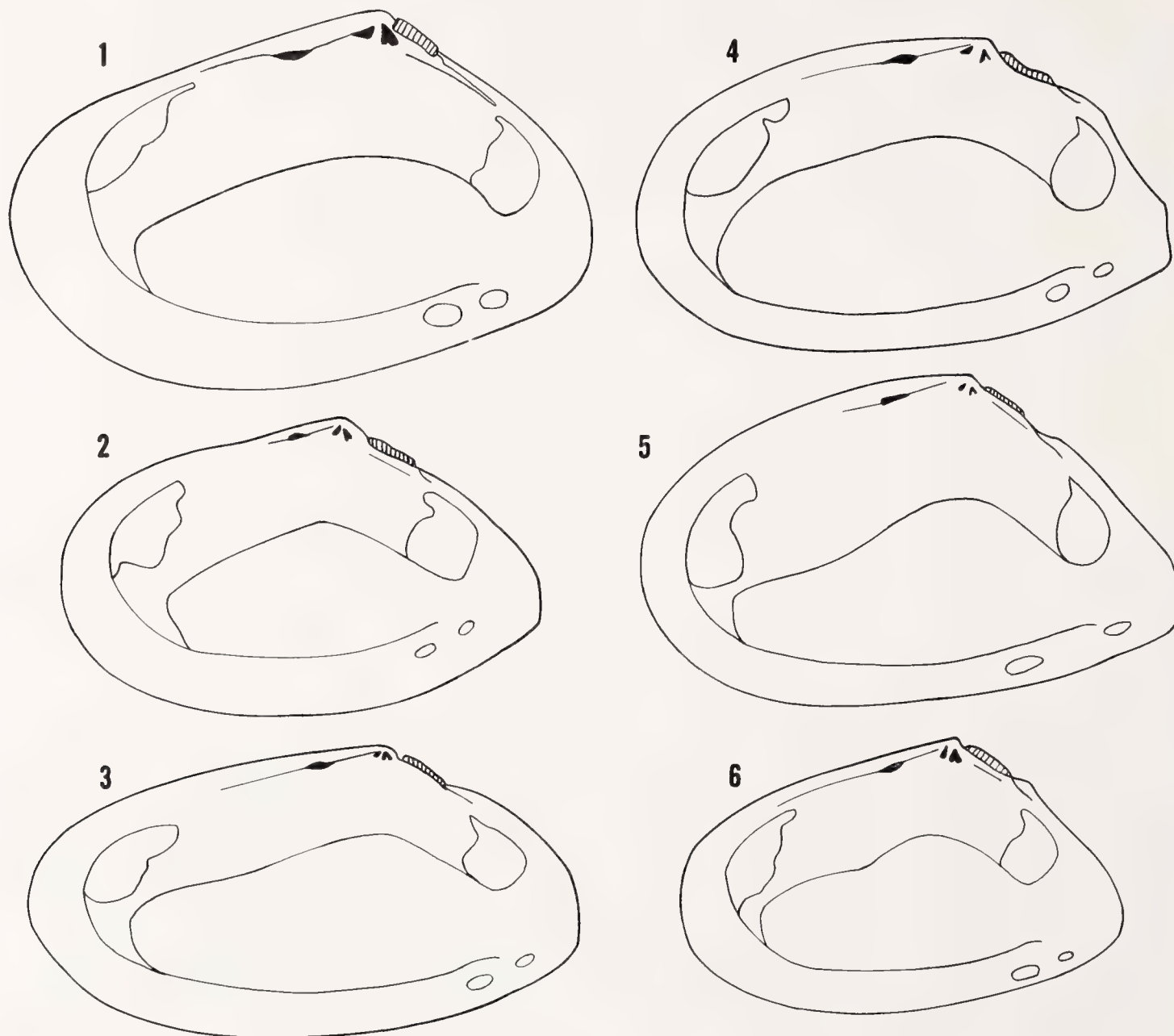


Plate 157. Figs. 1–6. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina tenella* (Verrill) (about 8x) [L=8.5 mm.]. Fig. 2. *Tellina agilis* Stimpson (about 5x) [L=12.5 mm.]. Fig. 3. *Tellina sybaritica* Dall (about 9x) [L=6.8 mm.]. Fig. 4. *Tellina gibber* von Ihering (about 5.5x) [L=15 mm.]. Fig. 5. *Tellina exerythra* Boss (about 7x) [L=10.3 mm.]. Fig. 6. *Tellina texana* Dall (about 4.4x) [L=13 mm.].

***Tellina (Angulus) exerythra* Boss**

Plate 156, fig. 4; Plate 157, fig. 5

Tellina (Angulus) exerythra Boss 1964, Occ. Pap. Dept. Mollusks, Harvard Univ. 2: 315, pl. 55, fig. 7 (Boca del Infierno, Bahia de Samana, Santo Domingo, Hispaniola; holotype, MCZ 239220).

Tellina (Eurytellina) vespuciana 'd'Orbigny' Dall and Simpson 1901, Bull. U.S. Fish. Comm., 20(1): 480, non d'Orbigny 1842.

Description. Shell extending to 18.5 mm. (about $\frac{3}{4}$ inch) in length and to 11 mm. (about $\frac{3}{8}$ inch) in height, subtrigonal, subsolid to solid, inflated with the left valve more

convex and with a variously developed posterior flexure to the right. Umbos just posterior to the middle, slightly elevated and pointed. Anterior margin broadly rounded; ventral margin slightly convex and rising in a gentle arcuation posteriorly; anterior dorsal margin elongate and convex; posterior dorsal margin rather steeply inclined and straight; posterior margin short, parallel to the dorso-ventral axis and forming a small truncation. Concentric sculpture consisting of more or less widely and evenly spaced sulci separated by broad, flattened bands; no radial sculpture. Ligament light brown, weak and protuberant. Calcareous portion of the ligament subtended by short and weak nymphal callosities. In the left valve, the cardinal complex consists of an anterior elongate bifid tooth with subequal lobes and of a posterior elongate laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior, skewed and thickened bifid tooth with subequal lobes and of an anterior subdeltoid laminate tooth; anterior lateral tooth thickened, upcurled and proximal to the cardinal complex; small distal vestige of the posterior lateral tooth evident. Adductor muscle scars moderately impressed. Anterior adductor scar elongate and rounded below; posterior adductor scar rounded. Pallial sinus more or less equal in both valves, rising gently posteriorly, descending in a concave line, extending nearly to but separated from the anterior adductor muscle scar and falling in a short rounded arcuation to the pallial line. Shell basically ivory white in color with a predominance of red suffusion; the periphery is generally white, and variously formed rays of red, white or pink underlie the posterior ridge; external surface shining and sometimes iridescent; internal surface generally highly polished.

length	height	width	
12.0 mm.	7.0 mm.	3.5 mm.	Holotype of <i>exerythra</i> Boss
18.3	11.0	—	West Indies
14.8	8.5	—	Santa Barbara de Samana, Santo Domingo
12.8	7.4	3.4	“ “ “ “ “ “
10.3	6.5	3.0	Mayaguez, Puerto Rico
7.0	4.3	1.9	Bahia de Samana, Santo Domingo

Remarks. *Tellina exerythra* occurs in considerable numbers in the two easternmost islands of the Greater Antilles. It is most easily confused with and closely related to *T. versicolor*. In general, *exerythra* is subtrigonal in shape, bright red in color and relatively high in proportions. In this respect it can be contrasted with the elongate elliptical shape and whitish coloration of *versicolor*. The shell of *exerythra* is thicker, heavier and of a greater convexity than that of *versicolor*. The posterior ridges of *exerythra* are rather strongly developed, and there are generally one or two supernumerary ridges separated by weak sulci upon the posterior slope. In contrast, *versicolor* possesses less definitively developed posterior ridges, and extra ridges do not seem to be present.

In the south Atlantic, *Tellina gibber*, because of its strong shell and the configuration of its pallial sinus, may be related to *exerythra* but *gibber* lacks the red coloration and possesses a distinctly divided posterior margin with a peculiar and strongly developed posterior sulcus.

Tellina erythronotus Pilsbry and Lowe of the Eastern Pacific is quite similar to *T. exerythra* but the Pacific species attains a greater size.

Range. The species appears to be concentrated in the area of the Greater Antilles exclusive of Cuba. Some specimens have been found at Colón, Panamá and others in Brasil.

Specimens examined. BRITISH HONDURAS: Belize and Monkey River (ANSP). GUATEMALA: Livingston and Puerto Barrios (ANSP). JAMAICA: Little Goat Island, Portland Bight (MCZ). HISPANIOLA. HAITI: Aquin; Bizoton (both USNM). SANTO DOMINGO: Monte Cristi (ANSP); Puerto Plata (MCZ); Matanzas (USNM); Santa Barbara de Samana (MCZ); 3 miles E of Sanchez (USNM); Boca del Infierno (MCZ). PUERTO RICO: Mayaguez (IMBPR; USNM; MCZ); Puerto Real; Cayos Finos, off Ponce (both IMPBR). PANAMÁ: Colón (MCZ); Mt. Hope, Pleistocene (ANSP). BRASIL: Thayer Expedition (MCZ).

***Tellina (Angulus) probrina* Boss**

Plate 155, fig. 1; Plate 159, fig. 3

Tellina (Angulus) probrina Boss 1964, Occ. Pap. Dept. Mollusks, Harvard Univ., 2: 319, pl. 55, fig. 4 (*Eolis* station 151, off Fowey Light, Florida, in 55 fathoms; holotype, USNM 461905).

Description. Shell extending to 25 mm. (about 1 inch) in length and to 14 mm. (about 9/16 inch) in height, elongate to subrectangular in shape, fragile, compressed, with the left valve of slightly greater convexity and with a slight posterior flexure to the right. Umbos posterior to the middle, small and pointed. Anterior margin broadly rounded; ventral margin straight to slightly convex; anterior dorsal margin long and gently sloping; posterior dorsal margin short, slightly concave and slightly inclined; posterior margin long and forming an oblique and blunt truncation. Sculpture consisting of weakly incised and irregularly spaced, incised concentric sulci; no radial sculpture present. Ligament light brown and protuberant. The calcareous portion of the ligament is subtended by strongly developed and protuberant nymphal callosities in both valves. In the left valve, the cardinal complex consists of a narrow anterior bifid tooth with elongate lobes and of a thin and curved laminate tooth; no true lateral teeth. In the right valve, the cardinal complex consists of a strongly skewed posterior bifid tooth whose posterior lobe is the larger and of an anterior slightly thickened subdeltoid laminate tooth; anterior lateral proximal, laminate and curved upward; posterior lateral absent or obsolete. Adductor muscle scars moderately impressed. Anterior adductor muscle scar irregularly shaped, but elongate and rounded below; posterior adductor more or less rounded. Pallial sinus rising very abruptly from the posterior adductor muscle scar to a high point beneath the umbo, then gently descending, rounded anteriorly and arcuately falling to the pallial line. The pallial sinus is well separated from the anterior adductor muscle scar. Shell white to pink or flesh-colored with a variously shaped posterior ray which may be absent in bleached individuals. The periostracum imparts an iridescence to the external surface of the valves, and the internal surface may be shining.

length	height	width	
18.5 mm.	10.0 mm.	—	Holotype of <i>probrina</i> Boss
25.3	14.0	—	off Freeport, Texas
16.0	9.4	—	Bird Key, Florida
14.2	8.4	2.5 mm.	off Fowey Light, Florida
11.1	6.5	2.1	Sombrero Key, Florida
8.3	4.8	—	Bird Key, Florida

Remarks. *Tellina probrina* is most easily recognized by its subrectangular shape and its broad flattened and oblique posterior truncation. Young individuals closely assume

the proportions of average adults but very large individuals have the truncation more oblique and the anterior dorsal margin less gently inclined. The vitreous external appearance also identifies this species, but its nearest relative in the Western Atlantic, *Tellina euvitrea*, may be confused with it. However, *euvitrea* has a straight and peculiar anterior dorsal margin, nearly parallel with the ventral margin. In contrast to *probrina*, *euvitrea* is more tumid, much more pointed behind, and the pallial sinus does not rise so abruptly from the posterior adductor muscle scar.

Another species with which *Tellina probrina* may be confused is *T. consobrina*; however, the latter is distinctly allied to *Scissula* and its sculpture may be used to distinguish it from *probrina*. In addition, *probrina* is more compressed, higher in proportions, and more strongly and broadly truncate.

Range. This species occurs in depths up to 100 fathoms. It is found from off North Carolina south to Tobago.

Specimens examined. NORTH CAROLINA: *Eastward* station 1086, 33°42' N; 76°39.5' W, S of Cape Lookout, 140–145 meters (MCZ). SOUTH CAROLINA: *Gosnold* station 1403 (M 15), 32°50' N; 78°18.5' W, in 140–145 m. (A. Merrill). FLORIDA: off Government Cut, Miami; off Fowey Light; off Ragged Key; off Bird Key; off Triumph Reef (all USNM); off Sombrero Key (MCZ); off Sand Key; Key West; Dry Tortugas (all USNM). TEXAS: 68 miles SE of Freeport, in 48 fathoms; 80–100 miles S of Port Isabel, in 40 fathoms (both MCZ). BAHAMA ISLANDS: (USNM). LESSER ANTILLES: Grenada (USNM); 2 miles S of Fort George, Scarborough, Tobago, in 36 fathoms (MCZ).

***Tellina (Angulus) euvitrea* Boss**

Plate 156, figs. 3; Plate 159, fig. 2

Tellina (Angulus) euvitrea Boss 1964, Occ. Pap. Dept. Mollusks, Harvard Univ., 2: 321, pl. 55, fig. 5 (*Barrera* station 200, Santa Lucia, Cuba, in 2–4 fathoms; holotype, USNM 461952).

Description. Shell extending to 21 mm. (about 3/4 inch) in length and to 11 mm. (about 7/16 inch) in height, elongate-elliptical, thin, only slightly inflated with the right valve of a greater convexity and with only a slight flexure to the right posteriorly. Umbos just posterior to the middle, opisthogyrous, pointed and not elevated. Anterior margin very broadly rounded; ventral margin straight and with a slight postbasal arcuation; anterior dorsal margin not descending, long, straight and parallel to the ventral margin; posterior dorsal margin variously sloping and short; posterior margin short and poorly defined. Sculpture consisting of weak concentric sulci which are separated by broad bands. Radial sculpture consisting of extremely weak and obscure lirations which are more or less restricted to the peripheral areas. Ligament light brown, strong and protuberant. Calcareous portion of the ligament well developed and subtended by a short nymphal callosity. In the left valve, the cardinal complex consists of an anterior fragile bifid tooth and of a posterior thin and weak laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a strong posterior bifid tooth with a poorly developed sulcus and of a strong anterior and heavy laminate tooth; no true posterior lateral tooth present; anterior lateral proximal to the cardinal complex,

rather small and laminate. Adductor muscle scars generally well impressed. Anterior adductor scar irregularly elongate, smaller than the posterior scar. Pallial sinus equal in opposite valves, pointed above, descending rather steeply and smoothly arcuate anteriorly. The sinus is deep but is well separated from the anterior adductor muscle scar. Externally the shell is iridescent and banded with white or pink; internally, the shell is usually white.

length	height	width	
21.0 mm.	11.0 mm.	4.5 mm.	Holotype of <i>euvitrea</i> Boss
20.0	11.0	4.0	Bahia de Samana, Santo Domingo
11.0	6.0	—	Puerto Plata, Santo Domingo

Remarks. This species had actually been recognized by Dall and Simpson in their report on the mollusks of Puerto Rico, and it was at that time called '*Tellina vitrea* d'Orbigny', but the holotype of *vitrea* d'Orbigny is a young individual of *Tellina magna* Spengler. *Tellina euvitrea* is characterized by its periostracum which imparts a vitreous lustre to the external surface of the valves. Its closest relative in the Western Atlantic is *Tellina probrina*, from which *euvitrea* may be separated by a more gently rising pallial sinus, a more pointed posterior end, and by a peculiar anterior dorsal margin which is parallel to the ventral margin. In addition, *Tellina probrina* is compressed whereas *euvitrea* is somewhat inflated. Some individuals of *T. versicolor* may be confused with *euvitrea*, but generally the red coloration and the pallial sinus, which is closely aligned to the anterior adductor muscle scar in *versicolor*, serve to identify it.

Range. This species appears to be more or less restricted to the Greater Antilles except for Jamaica where it has not been recorded.

Specimens examined. CUBA: Santa Lucia, in 2–4 fathoms; La Esperanza, in 4–6 feet; Bahia Honda, in 1–12 fathoms; Cabanas Harbor, in 3–12 fathoms (all USNM). HISPANIOLA. SANTO DOMINGO: Puerto Plata (MCZ); Bahia de Samana (USNM). PUERTO RICO: Aquadilla; mouth of Añasco River, in 40–60 feet (both MCZ); Mayagüez, in 42–60 feet (IMBPR; USNM); off Ponce, in 50 feet (IMBPR).

***Tellina (Angulus) diantha* Boss**

Plate 154, fig. 3; Plate 159, fig. 4

Tellina (Angulus) diantha Boss 1964, Occ. Pap. Dept. Mollusks, Harvard Univ., 2: 323, pl. 55, fig. 6 (Barbados, British West Indies; holotype, MCZ 239110).

Description. Shell extending to 26 mm. in length (about 1 inch) and to 15 mm. (about $\frac{5}{8}$ inch) in height, elongate-subelliptical, thin, fragile, with the right valve of a greater convexity and with a slight flexure to the right posteriorly. Umbos posterior to the middle, inflated and blunt. Anterior margin generally narrowly rounded; ventral margin straight to slightly convex and rising posteriorly; anterior dorsal margin long and gently sloping; posterior dorsal margin straight and short; posterior margin short and forming a poorly defined, oblique truncation. Sculpture consisting of closely set, weakly developed concentric lines; no true radial sculpture present. Ligament light to dark brown and slightly protuberant. Calcareous portion of the ligament subtended by slightly protuberant nymphal callosities. In the left valve, the cardinal complex consists of an anterior

small, subdeltoid bifid tooth with subequal lobes and of a posterior, very thin, extremely elongate laminate tooth; a subproximal anterior lateral thickening represents a vestige of the anterior lateral tooth; no posterior lateral dentition. In the right valve, the cardinal complex consists of a posterior skewed bifid whose posterior lobe is much the larger and of an anterior short slightly thickened laminate tooth; the anterior lateral tooth is proximal to subproximal, thin, laminate and often weakly upcurled; no true lateral tooth present. Adductor muscle scars moderately impressed. Anterior adductor muscle scar narrow and rounded below; posterior adductor scar subquadrate. Pallial sinus more or less the same in opposite valves, rising gently behind, rounded above, descending gently in a more or less straight line and falling in an arcuation to the pallial line; the sinus is distinctly removed from the anterior adductor scar. Externally, shell smooth, shining and suffused with pink or yellowish green; internally, chalky.

length	height	width	
26.5 mm.	15.0 mm.	7.0 mm.	Holotype of <i>diantha</i> Boss
23.0	14.0	7.5	Totness, Coronie, Surinam
22.3	13.0	6.4	Rio de Janeiro, Brasil
22.0	13.1	6.0	Belem, Brasil

Remarks. The relationship of this species with others obviously allied to it is obscured by its apparent rarity and the fact that no ontogenetic series of specimens has yet been collected. The large adult size of this species quickly distinguishes it from other members of *Angulus*, but such a character is unsatisfactory as a diagnostic trait. The peculiarly elongate posterior cardinal tooth in the left valve possesses some diagnostic value. In addition, the width and general tumidity of the valves constitutes a further aid in identification.

The closest relatives of this species are *Tellina euvitrea* and *T. probrina*. With respect to both of these species, *diantha* is more tumid and of a different outline, possessing a poorly differentiated posterior truncation and a comparatively shorter anterior dorsal margin. The umbo in *diantha* is more nearly equilateral although still behind the middle and the pallial sinus does not rise abruptly from the posterior adductor muscle scar and extends more anteriorly than in either *euvitrea* or *probrina*.

A fine series of *diantha* has been found by Altena in Surinam. The series from Totness, Coronie, consists of two complete specimens plus five right valves and two left valves. They are designated as paratypes for this species; the specimens are preserved in the Rijksmuseum van Natuurlijke Historie, Leiden.

Range. Although there are only a few records for the species they indicate a rather extensive range, from the Barbados in the Lesser Antilles south to Rio de Janeiro, Brasil.

Specimens examined. LESSER ANTILLES: Barbados (MCZ). SURINAM: Totness, Coronie (Rijksmuseum, Leiden). BRASIL: Belem, Para (MCZ); Rio de Janeiro (USNM).

***Tellina (Angulus) gibber* von Ihering**

Plate 154, fig. 4; Plate 157, fig. 4

Tellina (Angulus) gibber von Ihering 1907, Anales del museo Nacional de Buenos Aires, 14, Ser. 3a, 7: 456, pl. 18, figs. 126 a-b (Puerto Militar, Bahia Blanca) [holotype, Museo Nacional de Buenos Aires, Argentina].

Description. Shell extending to 19.5 mm. (about $\frac{3}{4}$ inch) in length and to 10.5 mm. (about $\frac{3}{8}$ inch) in height, elongate-elliptical, fragile to subsolid, rather compressed, with the valves more or less equal in convexity and with little or no posterior flexure. Umbos posterior to the middle and blunt. Anterior margin narrowly rounded; ventral margin rounded in front, convex and rising posteriorly; anterior dorsal margin rather long and more or less straight; posterior dorsal margin often divided into two sections, one a straight and short portion immediately above the hinge line and the other a longer convex posterior portion; posterior margin short and forming a small blunt truncation. Sculpture consisting of regularly spaced, finely incised concentric sulci (about 4–7 per millimeter) separated by broad flattened bands; extremely fine radial lirations may occur on the disc. A posterior ridge and a variously developed sulcus, which bisects the posterior slope, occurs in both valves. In the left valve the cardinal complex consists of an anterior thickened bifid tooth with subequal lobes and of a posterior thin laminate tooth; no true lateral teeth developed. In the right valve, the cardinal complex consists of a posterior subdeltoid, slightly skewed bifid tooth whose posterior lobe is larger and of an anterior thickened subdeltoid laminate tooth; the anterior lateral tooth thin, elongate and proximal to the cardinal complex; the posterior lateral tooth distal, thin and socketed. Adductor muscle scars poorly impressed. Anterior adductor larger, longer and narrower than the posterior. Pallial sinus equal in opposite valves, rising only slightly behind, convex above and descending in an arcuation to the pallial line. The sinus does not touch and is rather widely separated from the anterior adductor scar. Externally, the shell is white, shining and somewhat iridescent; periostracum greenish or brownish; internally, polished and white.

length	height	width	
16.0 mm.	9.5 mm.	4.0 mm.	Holotype of <i>gibber</i> von Ihering
19.5	10.5	5.0	off Benninga, Argentina
16.5	9.5	4.5	Puerto Quequen, Argentina
12.5	7.5	3.5	Puerto Quequen, Argentina
9.2	5.0	2.1	La Paloma Rocha, Uruguay
5.0	2.6	—	off Montevideo, Uruguay

Remarks. The character which clearly separates this species is the presence of a sulcus which bisects the posterior slope. The sulcus is variously developed and in some specimens is so strong as to give the shell a constricted appearance. The posterior dorsal slope is also divided into two portions by the sulcus, thereby making the posterior slope appear very short and blunt.

The species is an off-shore dweller and seems to have a preference for depths between 7 and 30 fathoms. The nearest discernible relative is *Tellina hiberna* Hanley of the Eastern Pacific, which compares with *gibber* in the similarity of the peculiar sulcal configuration of the posterior margin and slope; however, *hiberna* is more attenuated posteriorly, the sculpture a little more coarse, the umbo further behind the middle and the shell a bit thinner. *Tellina gibber* was originally described as a fossil and is present in the Tertiary of Argentina and Uruguay (Figueiras, 1962).

Range. This species is strictly southern in its distribution. It is found from off the coast of Uruguay at La Paloma Rocha south along the coast of Argentina to Golfo San Matias.

Specimens examined. URUGUAY: La Paloma Rocha; off Montevideo, in 7 fathoms

(both MCZ). ARGENTINA: Puerto Quequen, Buenos Aires; off Cabo Bermeja, off Benninga Head, and off Balem Head, Golfo San Matias, in 17–25 fathoms (all USNM).

Tellina (Angulus) tenella Verrill
Plate 157, fig. 1; Plate 158, figs. 3–4

Angulus modesta Verrill 1872, Amer. Jour. Sci., 3: 211 (typographical error).
Angulus modestus Verrill 1872, Ibid., p. 285, pl. 6, figs. 2–2a (Vineyard Sound, Buzzard’s Bay, and Long Island Sound, off New Haven) [syntypes, Peabody Museum, Yale Univ.], non Carpenter 1864.
Angulus modestatus Verrill [in] Verrill and Smith 1874, Report upon Invert. Animals of Vineyard Sound and Adjacent Waters, p. 124 (typographical error).
Angulus tenellus Verrill [in] Verrill and Smith 1874, Ibid., p. 383, pl. 30, fig. 224, non *tenella* Jeffreys 1881, new name for *modestus* Verrill.
Tellina tenella Verrill. Dall 1889, Bull. no. 37, U.S. Nat. Mus., p. 60, pl. 56, fig. 12.
Tellina (Angulus) tenella Verrill. Dall 1900, Proc. U.S. Nat. Mus., 23: 295.

Description. Shell extending to 10 mm. (about $\frac{3}{8}$ inch) in length and to 6.4 mm. (about $\frac{1}{4}$ inch) in height, subelliptical, solid, slightly tumid, with both valves of equal convexity and without a posterior flexure. Umbos elevated, small and blunt. Anterior margin narrowly rounded; ventral margin rounded and with a postbasal arcuation; anterior dorsal margin long and concave; posterior dorsal margin steeply inclined, short and concave; posterior margin short, convex and forming a rounded blunt truncation. Sculpture consisting of closely spaced, concentric sulci separated by rounded bands; no true radial sculpture present. Ligament light brown, short and protuberant. Calcareous portion of the ligament not strongly developed; nymphal callosities not prominent. In the left valve, the cardinal complex consists of an anterior small subdeltoid bifid tooth with subequal lobes and of a posterior, short and thin laminate tooth; no lateral teeth present. In the right valve, the cardinal complex consists of a posterior slightly skewed subdeltoid bifid tooth whose posterior lobe is much the larger and of an anterior thickened subdeltoid laminate tooth; anterior lateral tooth proximal to the cardinal complex and thickened; no posterior lateral present. Adductor muscle scars generally well impressed. Anterior adductor scar narrow, subrectangular and rounded below; posterior adductor scar almost perfectly round. Pallial sinus more or less equal in both valves, gently and only slightly rising, convex above, rounded anteriorly and falling in a smooth arcuation to the pallial line. The pallial sinus is distinctly separated from the anterior adductor muscle scar. Interior surface of valves roughened and thick. Color generally white but sometimes brownish or reddish.

length	height	width	
10.0 mm.	6.4 mm.	2.5 mm.	Vineyard Sound, Massachusetts
9.3	6.2	2.5	Woods Hole, Massachusetts
9.0	5.5	2.5	Sanibel Island, Florida
8.2	5.4	2.5	Sarasota, Florida
3.5	2.0	—	off Cape Hatteras, North Carolina

Remarks. Part of the obscurity which has surrounded this specific name was caused by the plethora of errors committed in its original designation and its comparison with *Angulus tener* (*Tellina agilis*). The specific name was first introduced as *Angulus modesta*; the spelling is a typographical error since Verrill used ‘*modestus*’ in the original description. The type figure, pl. 6, figs. 2–2a, is good, but in the text of the description,

Verrill refers to pl. 7 (also an error), fig. 1 as that of *modestus* and fig. 2 as that of *A. tener* (*T. agilis*) so unfortunately some workers confused the two.

Tellina tenella is a distinct and somewhat rare species, being originally restricted to the Long Island and Vineyard Sound area in the north; however, its range was greatly extended by Dall (1889) and then later altered by him (1900a). Under the present interpretation, the species extends from the Woods Hole region in the north to the west

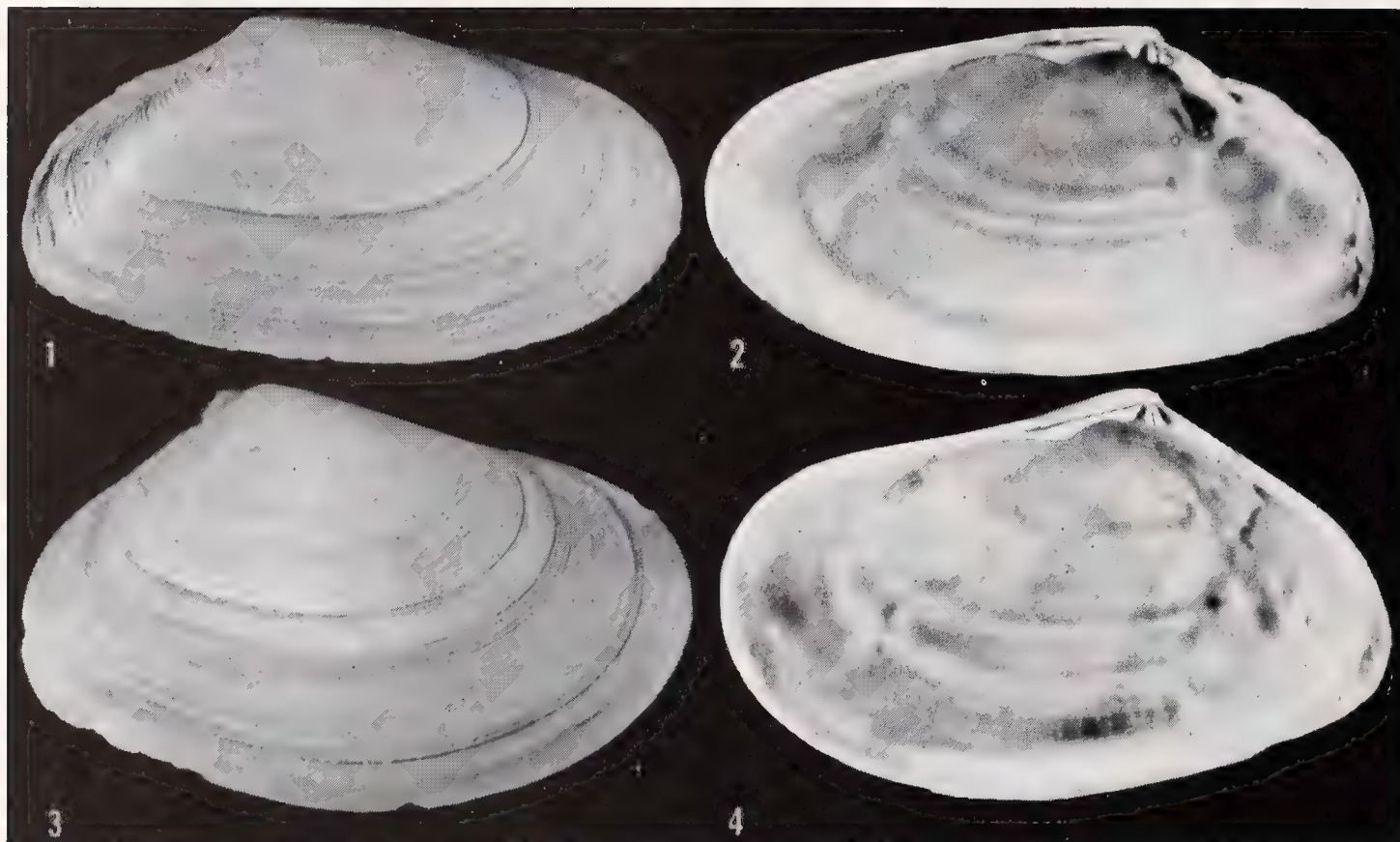


Plate 158. Figs. 1-2. *Tellina sybaritica* Dall. Fig. 1. External view of the right valve. Fig. 2. Internal view of the right valve, off Cabo Catoche, Mexico, USNM 323145 (about 8x) [L=8.5 mm.]. Figs. 3-4. *Tellina tenella* (Verrill). Fig. 3. External view of the right valve. Fig. 4. Internal view of the right valve, Vineyard Sound, Massachusetts, Yale 76973 (about 8x) [L=9 mm.].

coast of Florida. Over the extent of this range, a considerable amount of variation is evident. As shown in the descriptive measurements given above, the normal proportions are somewhat altered in the southern populations of *tenella*. With its finely incised, regularly spaced sculpture, *Tellina tenella* is allied to *T. sybaritica* but the latter is much more inflated, more highly colored, flexed behind, and of lower proportions. From *T. agilis*, which is more distantly removed than *T. sybaritica*, *tenella* may be distinguished by its arcuate ventral margin, its elongate, concave anterior dorsal margin and its shorter and more blunt posterior truncation. In addition, the pallial sinus approaches the anterior adductor muscle scar much more closely in *tenella* than in *agilis*. *Tellina pygmaea* Philippi of Europe bears some resemblance to *T. tenella*, but the former possesses a more distantly removed right anterior lateral tooth, is more highly colored and of a greater convexity.

Range. This species occurs from Woods Hole to south of Cape Lookout, and in the Gulf of Mexico, it is found along the west coast of Florida to Mississippi.

Specimens examined. MASSACHUSETTS: Swift's Beach, Wareham (USNM); Buzzards Bay (ANSP); Woods Hole (USNM; MCZ); off Gay Head Light, in 10-13 fathoms

(USNM); off Martha's Vineyard (ANSP); off Noman's Land (USNM). NORTH CAROLINA: off Beaufort, in 6–9 fathoms; off Cape Hatteras, in 15–18 fathoms; off Cape Lookout, in 18–31 fathoms (all USNM). FLORIDA: Sanibel (MCZ); Charlotte Harbor; Sarasota Bay (both USNM); Destin (MCZ); St. Josephs Bay; Crooked Island, St. Andrews Sound (both ANSP). MISSISSIPPI: Horn Island (ANSP).

***Tellina (Angulus) sybaritica* Dall**

Plate 157, fig. 3; Plate 158, figs. 1–2

Tellina sybaritica Dall 1881, Bull. Mus. Comp. Zool., **9**: 134; 1886, Bull. Mus. Comp. Zool., **12**(6): 27, pl. 6, fig. 11 (Yucatan Strait, in 640 fathoms) [holotype, USNM 333600].

Tellina (Angulus) flagellum Dall 1900, Proc. U.S. Nat. Mus., **23**: 312, pl. 2, fig. 6 (off Cape San Roque, Brasil, in 20 fathoms) [holotype, USNM 108534].

Tellina (Angulus) rubricata Perry 1940, Nautilus, **53**(3): 79 (off Blind Pass, Sanibel Island, Florida, in 5 fathoms) [holotype, ANSP].

Description. Shell extending to 11 mm. (about $\frac{3}{8}$ inch) in length and to 5.7 mm. (about $\frac{1}{4}$ inch) in height, elongate, bluntly pointed behind, solid, rather inflated with the left valve of greater convexity and with a posterior flexure to the right. Umbos posterior to the middle, small and pointed. Anterior margin narrowly rounded; ventral margin convex and rising in a gentle arcuation behind; anterior dorsal margin elongate and gently inclined; posterior dorsal margin short and convex; posterior margin irregular, biangulate and forming a produced and blunt truncation. Concentric sculpture consisting of regularly spaced incised sulci separated by rounded lirations; no true radial sculpture. Ligament light brown, strong and set in a shallow escutcheon. Calcareous portion of ligament subtended by weak nymphal callosities. In the left valve, the cardinal complex consists of an anterior narrowly elongate bifid tooth with equal lobes and of a posterior thin, short laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior skewed, slightly thickened bifid tooth whose posterior lobe is the larger and of an anterior laminate tooth often coextensive with the anterior lateral tooth; anterior lateral tooth proximal to the cardinal complex, thickened and upcurled; posterior lateral tooth obsolete. Adductor muscle scars moderately well impressed, often obscured by the polished internal surface of the valves. Anterior adductor scar elongate to ovate, irregular above, rounded below; posterior adductor scar irregularly subquadrate. Pallial sinus equal in opposite valves, descending in a concave line to and nearly touching the anterior adductor muscle scar and then falling to the pallial line. Basic color predominantly white and suffused with red, yellow, pink or peach; red or pink rays extend postbasally from the umbonal region along the posterior slope.

length	height	width	
10.5 mm.	5.5 mm.	3.7 mm.	Holotype of <i>sybaritica</i> Dall
9.0	5.0	3.0	Holotype of <i>flagellum</i> Dall
8.0	4.1	—	Holotype of <i>rubricata</i> Perry
10.9	5.7	—	Castle Harbour, Bermuda
4.4	2.1	—	Cabo Catoche, Yucatan

Remarks. *Tellina sybaritica* is typically elongate with a long and slightly convex anterior dorsal margin and a short concave posterior dorsal margin; the posterior margin is irregularly biangulate and obliquely truncated. The shell is solid, thick and strong

with a tendency to be highly polished internally; the tumidity of the valves is considerable and distinctive, as is the more or less strong posterior flexure to the right. The sculpture consists of raised rounded ribs or lirations separated by shallow incised sulci, and as Dall noted, this configuration imparts a silky sheen to the surface of the valves.

By its relatively strong sculpture, *Tellina sybaritica* is related to *T. tenella*; however, the latter is distinguished by its lateral compression, its broad, blunt posterior truncation, and its lack of a posterior flexure to the right.

Tellina sybaritica converges with *Tellina vespuciana* d'Orbigny of the subgenus *Eurytellina*. The size, coloration, sculpture and shape of some individuals of these two species are extremely similar. The main trait which differentiates them is the strong development of the distal posterior lateral tooth in the right valve of *vespuciana*. In addition, *vespuciana* seems to possess a finer, intercalated umbonal sculpture and the umbo appears to be more pointed and elevated.

Range. This species is found from Beaufort, North Carolina south through the Greater and Lesser Antilles to Brasil.

Specimens examined. NORTH CAROLINA: off Beaufort, in 6-9 fathoms; off Cape Hatteras, in 11-22 fathoms; off Cape Lookout, in 18-52 fathoms; off Cape Fear, in 14-18 fathoms (all USNM). FLORIDA: St. Augustine; Lake Worth; Palm Beach; Triumph Reef; Long Reef; Ajax Reef; Key Largo; Turtle Harbor; Sambo Reef; Key West; Dry Tortugas (all USNM); Blind Pass and Tarpon Springs, Sanibel (both ANSP); Destin (MCZ). MEXICO: off Cabo Catoche, Yucatan, in 640 fathoms (USNM). BERMUDA: Castle Harbour; Harrington Sound (both MCZ). BAHAMA ISLANDS: Bimini;

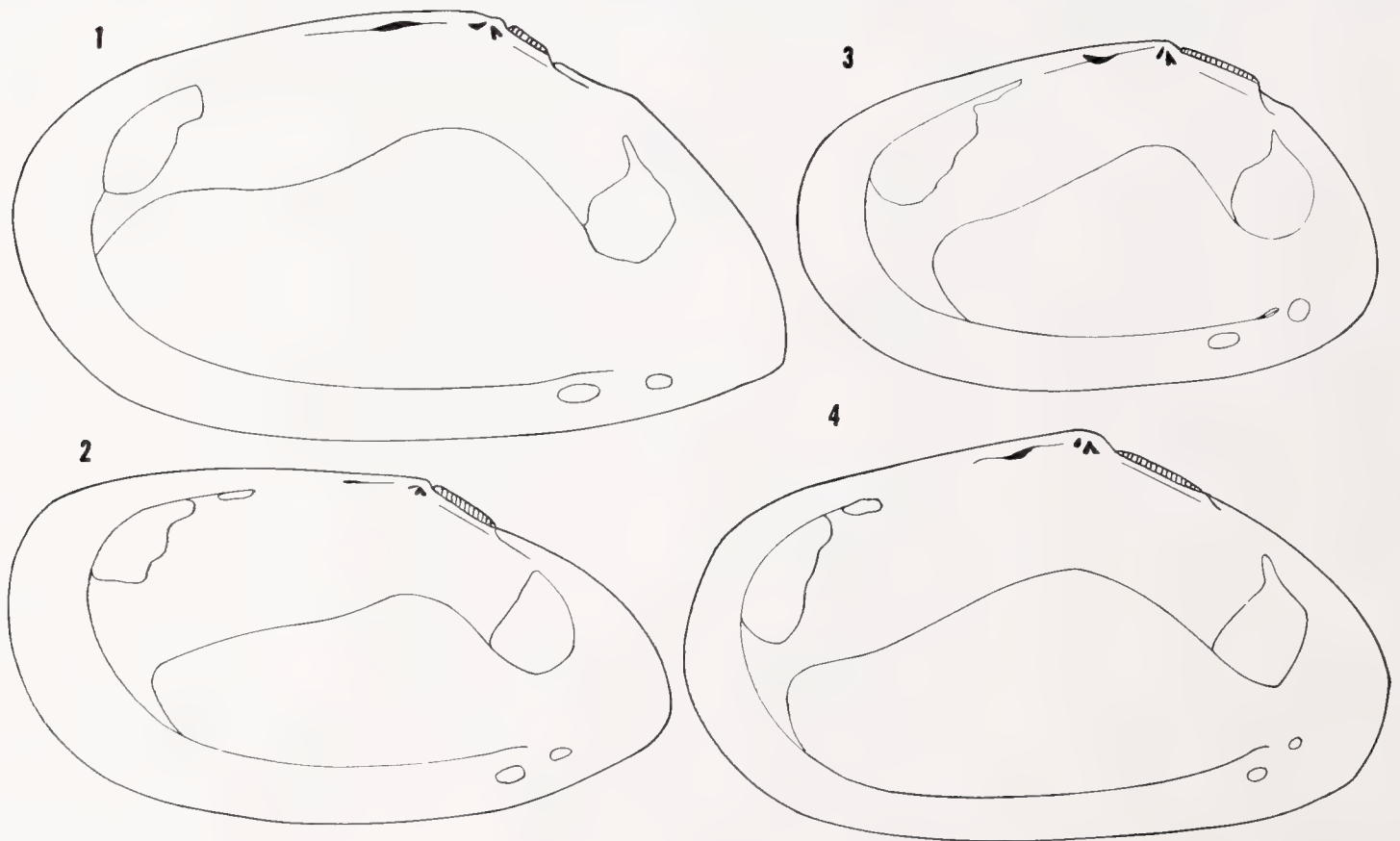


Plate 159. Figs. 1-4. Diagrammatic illustration of the internal surface of the right valve showing the dental configuration and muscle scars. Fig. 1. *Tellina versicolor* DeKay (about 6.8x) [L=12 mm.]. Fig. 2. *Tellina euvitrea* Boss (about 3.4 x) [L=21 mm.]. Fig. 3. *Tellina probrina* Boss (about 3.5x) [L=18 mm.]. Fig. 4. *Tellina diantha* Boss (about 3.5x) [L=22 mm.].

New Providence; Andros (all USNM). CUBA: Cape Cajon; Punta Tolete; Santa Rosa; Bahia Honda; Cabanas (all USNM); Habana; Matanzas; Banes (all MCZ). JAMAICA: (MCZ). HISPANIOLA. HAITI: Jeremie (USNM); Bizoton (MCZ). PUERTO RICO: Mayagüez (IMBPR); La Parguera (MCZ); San Juan Harbor (USNM). LESSER ANTILLES: St. Lucia; Tobago (both MCZ). CARIBBEAN ISLANDS: Grand Cayman (ANSP). BRASIL: off Natal; off Cape San Roque, in 20 fathoms; off Aracaju, Bahia in 12 fathoms (all MCZ).

Subgenus *Scissula* Dall

Scissula Dall 1900, Proc. U.S. Nat. Mus., 23: 291 (type species, *Tellina decora* Say 1826 [= *Tellina similis* Sowerby 1806], original designation).

Cirsula Dall. Cary and Spaulding 1909, Bull. Gulf. Biol. Sta., 12: 21, error for *Scissula*.

Description. Shell of small to medium size (up to $1\frac{1}{8}$ inches), and with or without a posterior flexure to the right. Sculpture consisting of weak, concentric lirations crossed by incised lines or scissulations which descend from the anterior slope or margin to the ventral margin. The posterior slope lacks the scissulate pattern of sculpture. Right anterior lateral tooth strong, laminate, and immediately proximal to the cardinal complex: all other laterals absent or obsolete. Pallial sinus rather extensive and deep but not coalescent with the anterior adductor muscle scar. Color of the shell white or red, suffused or rayed with white, red or yellow.

Scissula reaches its greatest development in the Eastern Pacific and, particularly, in the Western Atlantic regions. It is more or less tropical and subtropical in its distribution. In the Western Atlantic only a single species has a normal range which extends as far north as Cape Hatteras. In the Eastern Pacific, the northernmost limit for the subgenus appears to be the Gulf of California. In the Indo-Pacific, the group does not seem to have attained a similar level of development but such species as *Tellina micans* Hanley are decidedly scissulate and represent the subgenus in that realm. According to Woodring (1925), the earliest ancestors of the Western Atlantic species appeared in the Lower Miocene.

The precise definition of the subgenus delimits those species with scissulate sculpture on both valves. The content and status of *Scissula* has been contested by Salisbury (1934) who included the group with *Fabulina* Gray. The latter is uniquely typified by *Tellina fabula* Gmelin in which only the right valve is scissulate; this species is European and Mediterranean in its distribution. Since the structure of the right lateral dentition and the configuration of the pallial sinus in *Fabulina* and *Scissula* are very similar, a close relationship between the two groups cannot be denied. The approach of Thiele (1935) however will be employed in the present consideration, and *Scissula* and *Fabulina* will be treated as separate but closely allied subgenera.

Scissula is clearly related to the anguloid subgenera. The right valve possesses the diagnostic dental characteristics. The right anterior lateral tooth is typically long, thin, or shelf-like, more or less upturned, and closely adjacent to the cardinal complex. The right posterior lateral tooth is generally obsolete, except in *Tellina candeana*.

KEY TO THE SPECIES OF *SCISSULA* IN THE WESTERN ATLANTIC

1. Shell subtrigonal and subsolid *candeana*
 Shell elongate-elliptical 2
2. Shell thin and fragile; generally with two posterior rays 3
 Shell thicker, not fragile, and often with numerous rays 4
3. Shell white; scissulations broadly spaced (4–6 mm.) *iris*
 Shell purple; scissulations closely spaced (6–10 mm.) *sandix*
4. Shell with strong concentric sculpture differentiated along the right
 posterior slope *similis*
 Shell without distinctly differentiated concentric sculpture on the
 right posterior dorsal slope *consobrina*

***Tellina (Scissula) similis* Sowerby**

Plate 160, figs. 1–2

Tellina similis Sowerby 1806, British Miscellany, 2: 29, pl. 75 (Brighton, England) [type locality, here restricted and corrected, Pelican Shoal, Florida; lectotype, here selected and figured, BMNH].

Tellina decora Say 1826, Jour. Acad. Nat. Sci., Philadelphia, 5: 319 (southern coast of East Florida) [type locality, here restricted, South Inlet, Lake Worth, Florida; syntypes, ANSP 52427].

Tellina caribaea d'Orbigny 1842 [in] Sagra, Hist. L'Ile Cuba, Atlas, pl. 25, figs. 47–49; 1845, Spanish Text, 2(5): 303 (Cuba y la Guadalupe); 1853, French Text, Mollusques, 2: 251 [type locality, here restricted, Cuba; lectotype, here selected and figured, BMNH].

Tellina iris 'Say' Philippi 1845, Abbildungen und Beschreibungen, 2: **Tellina**, p. 25, pl. 3, fig. 5.

Tellina eupareia Ravenel 1885, Proc. Elliot Soc., 2(5): 37 (Sullivan's Island, South Carolina) [type lost].

Tellina (Scissula) similis Sowerby. Dall 1900, Proc. U.S. Nat. Mus., 23: 296.

Description. Shell extending to 27.5 mm. (about $1\frac{1}{8}$ inches) in length and to 18.5 mm. (about $\frac{3}{4}$ inch) in height, elongate, subsolid to fragile, with the left valve more convex and with a strong posterior flexure to the right. Umbos posterior to the middle, opisthogyrous and blunt. Anterior margin smoothly and narrowly rounded; ventral margin convex and rising slightly posteriorly; anterior dorsal margin long, gently sloping and convex; posterior margin long and forming an oblique truncation. Sculpture consisting of weak concentric lirations which are strong on the right posterior slope and of acentric scissulations (about 7–9 per millimeter). Ligament light brown, short, broad, and protuberant. Calcareous portion of the ligament well developed and subtended by nymphal callosities. In the left valve, the cardinal complex consists of an anterior narrow, elongate, and strongly sulcated bifid tooth with equal lobes and of a thin, but strong laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior skewed bifid tooth whose posterior lobe is the larger and of an anterior thickened laminate tooth; anterior lateral tooth proximal to the cardinal complex, strong, and flangelike; posterior lateral tooth absent. Adductor muscle scars well impressed. Anterior adductor slightly larger and higher than the posterior adductor. Pallial sinus equal in both valves, rising slightly behind, convex above, and extending very near to but not coalescing with the anterior adductor. Externally the shell is predominantly white, sometimes suffused with yellow, red, or apricot; there are bands and rays of pink or red. Internally, the shell is shining and sometimes highly polished with the general color characteristics of the external surface.

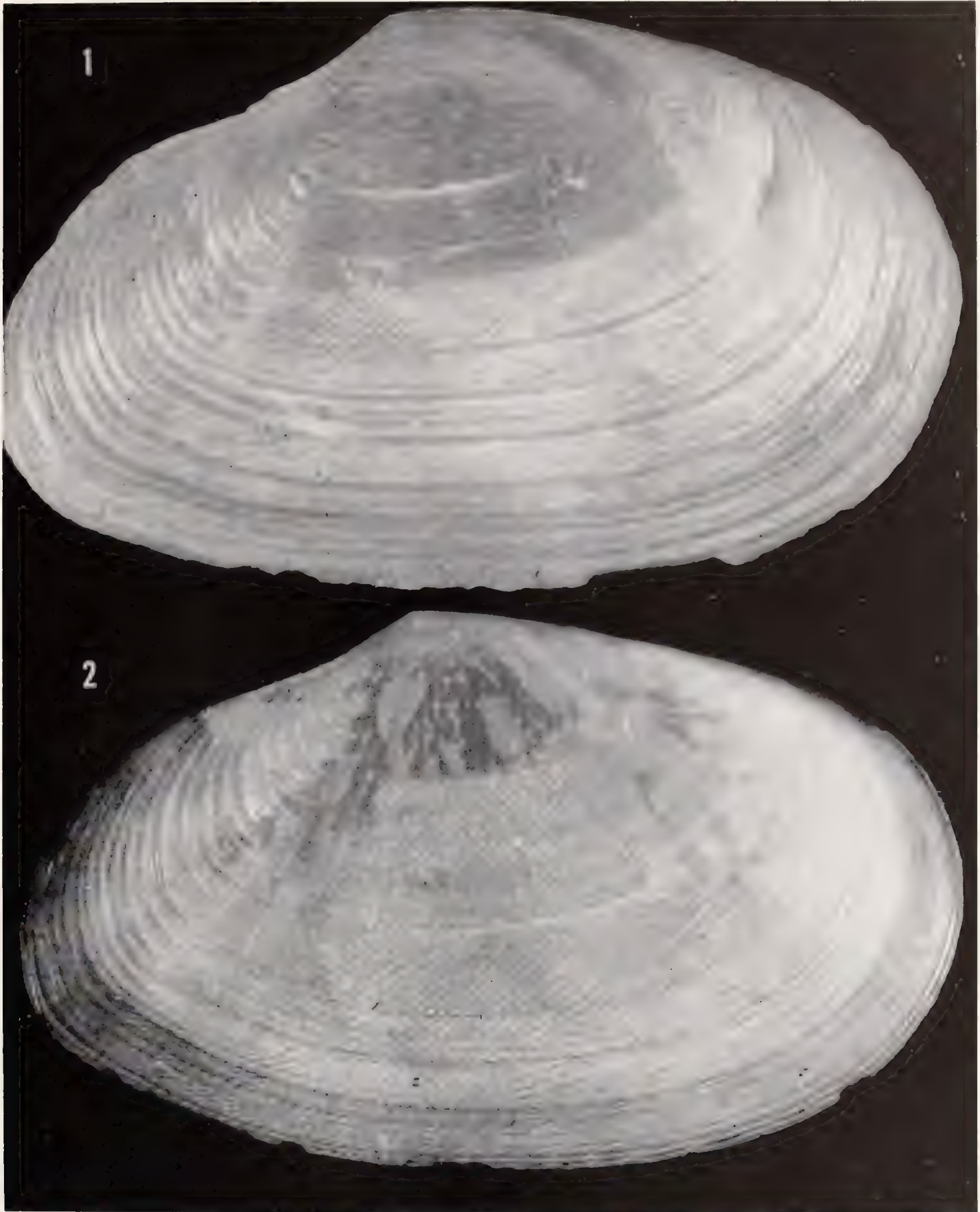


Plate 160. Fig. 1. *Tellina similis* Sowerby, external view of the right valve of the lectotype, Brighton, England, BMNH (about 9x) [L = 17.5 mm.]. Fig. 2. *Tellina caribaea* d'Orbigny [= *Tellina similis* Sowerby], external view of the right valve of the lectotype, Cuba, BMNH (about 9x) [L = 16.6 mm.].

length	height	width	
17.5 mm.	10.5 mm.	—	lectotype of <i>similis</i> Sowerby
16.6	9.7	4.3	lectotype of <i>caribaea</i> d'Orbigny
27.5	18.5	9.0	Tarpon Bay, Sanibel, Florida
18.0	11.5	6.0	Missouri Key, Florida
13.5	8.5	4.0	Cayo Caiman, Caibarien, Cuba
11.0	7.0	3.0	Grassy Key, Florida

Remarks. Among other Western Atlantic tellinids, *similis* might well be confused with *Temnoconcha brasiliiana* Dall, for there is a superficial similarity of shape in these two species. A careful examination of the hinge mechanism and the dental formula will always show *similis* to be laterally dentate and *brasiliiana* laterally edentate.

Tellina consobrina appears to be most closely related to *T. similis*. In the lack of differentiated posterior slope sculpture and in the obsolete condition of the scissulate sculpture, *consobrina* departs markedly from *similis*. *Tellina candeana*, because of the thickness of its valves and the disposition and spacing of the scissulations, may also be considered a close relative of *similis*. The two differ greatly in shape, *similis* being subquadrate, and *candeana* being subtrigonal, and the latter possesses a rather distinct right posterior lateral tooth. There is no analog of *similis* in the Eastern Pacific.

The fossil history of *Tellina similis* begins in the Oligocene [Miocene] of the Chipola horizon at Alum Bluff where Dall (1900b) has described *Tellina lampra*, which differs from the modern *similis* in being more inequilateral and, according to Dall, being differently shaped posteriorly. True *T. similis* appears in the Pliocene of the Caloosahatchie River, Florida, and it has been recorded in Pleistocene deposits on Grand Cayman Island in the Caribbean by Rehder (1962).

The depth range of this species includes shallow shore as well as off-shore records up to 130 fathoms. Bottom type preference seems to be limited to sand, particularly coarse sand.

Range. This species occurs normally from along the east coast of Florida in the vicinity of Lake Worth, south through the Antilles to Barbados and west as far as Panama; it has not been recorded in Trinidad nor along the coast of eastern South America.

Specimens examined. SOUTH CAROLINA: Isle of Palms (CM). FLORIDA: South Inlet, Lake Worth (ANSP); off Palm Beach, in 10–130 fathoms (MCZ); off Miami, in 10–24 fathoms; Bird Key, Biscayne Bay; off Fowey Light, in 6–40 fathoms; Hawk Channel, in 3–4 fathoms; Elliott Key (all USNM); Sand Key (MCZ); Ajax Reef, in 4 fathoms; Caesar's Creek Bank, in 10 feet; off Turtle Harbor, in 20 fathoms (all USNM); off The Elbow, Key Largo, in 21 fathoms (MCZ); Lower Matecumbe Key; Long Key (both USNM); Little Duck Key (D. and N. Schmidt); Grassy Key; Bonefish Key; Marathon, Key Vaca (all ANSP); SE of Looe Key, in 25–50 fathoms (MCZ); Sugar Loaf Key (ANSP); Pelican Shoal; Tea Table Key; Missouri Key (all MCZ); off Key West, in 5–10 fathoms; Dry Tortugas (both USNM); Naples (ANSP); Tarpon Bay, Sanibel; Boca Grande Key; Longboat Key; Gulfport (all MCZ); Anclote (USNM). MEXICO: Progreso; off Isla Mujeres (both MCZ). PANAMA: Colon (USNM). BAHAMA ISLANDS: Holmes Cay; Angel Fish Point, Little Abaco (both MCZ); Pensacola Cays, in 3 fathoms; Cat Cay, in 3 fathoms (both USNM); Whale Cay Channel; Dick's Point, Nassau, New Providence; Savannah Sound, Eleuthera; Little San Salvador; Russell Creek, Cat Island; Simms, Long Island; Matthew Town, Great Inagua (all

MCZ). CUBA: Cape Cajon; Punta Colorado, in 2–3 feet; Bahia Hondo, in 1–12 feet; Santa Rosa, in 3–6 feet; Esperanza, in 4–6 feet; Habana; Cabanas Harbor, in 3–12 fathoms; Cardenas, in 1–3 fathoms (all USNM); Cayo Caiman, Cayo Frances, Cayo Salina and Cayo Lucus, Caibarien (all MCZ); Punta Alegre, Camaguey; Cayo Largo, Oriente (both ANSP). JAMAICA: (BMNH). HISPANIOLA. SANTO DOMINGO: Samana (USNM). PUERTO RICO: Cabo Rojo Light House (IMBPR). VIRGIN ISLANDS: SE of East Point, in 6–20 feet, Anegada; West End Point, in 2–6 feet, Anegada; St. Thomas (all ANSP). LESSER ANTILLES: Guadeloupe (MCZ); St. Vincent (BMNH); off Paynes's Bay Church and off Telegraph Street, Barbados (both USNM). CARIBBEAN ISLANDS: E end of Frank South and Georgetown, Grand Cayman (both ANSP).

***Tellina (Scissula) consobrina* d'Orbigny**

Plate 161, fig. 3; Plate 162, fig. 1

Tellina consobrina d'Orbigny 1842 [in] Sagra, Hist. L'Ile Cuba, Atlas, pl. 26, figs. 9–11; 1845, Spanish Text, 2(5); 305 (en la arena de la Martinica); 1853, French Text, Mollusques, 2: 254 [syntypes, BMNH 54.10.4.514].

Tellina (Angulus) consobrina d'Orbigny. McLean 1951, New York Acad. Sci., 17(1): 96, p. 19, fig. 8.

Description. Shell extending to 14 mm. (about 9/16 inch) in length and to 8 mm. (about 5/16 inch) in height, elongate, fragile to subsolid, rather tumid with the left valve of a greater convexity and with a posterior flexure to the right. Umbos posterior to the middle, not elevated, small and blunt. Anterior margin smoothly and narrowly rounded; ventral margin straight to gently convex; anterior dorsal margin elongate, gently sloping, and slightly convex; posterior dorsal margin short and concave; posterior margin straight and forming an oblique truncation. Sculpture consisting of narrowly spaced, weakly developed and somewhat irregular concentric lines crossed by acentric scissulations (about 3–5 per millimeter) which are often obscure. Ligament light brown in color and protuberant. Calcareous portion of the ligament subtended by flattened and thickened nymphal callosities. In the left valve, the cardinal complex consists of a narrow anterior bifid tooth with equal lobes and of a posterior, thin, elongate laminate tooth often adpressed to the calcareous element of the ligament; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior, strongly skewed bifid tooth whose posterior lobe is much the larger and of an anterior thin to subdeltoid laminate tooth; the proximal anterior lateral tooth of varying thickness, projecting and often slightly upcurled; no posterior lateral tooth. Adductor muscle scars usually well impressed. Anterior adductor irregularly shaped, but elongate and rounded below; posterior adductor rounded. Pallial sinus more or less equal in opposite valves, rising abruptly and descending gently, and rounded in front. The shell is white, variously colored with red or pink rays, rarely completely white, or with anterior suffusions of pink. The external surface is smooth and shining and generally not iridescent.

length	height	width	
14.2 mm.	7.9 mm.	3.8 mm.	off Fowey Light, Florida
13.5	7.7	3.3	Key West Channel, Florida
10.8	6.1	—	Key Largo, Florida
9.3	5.5	2.0	Barbados, Lesser Antilles
8.3	4.8	1.9	St. Thomas, Virgin Islands

Remarks. Early authors considered *Tellina consobrina* to be a variety or southern form of *Tellina versicolor* DeKay. Although the latter encompasses a great range of variation, it may be segregated from *consobrina* by its pallial sinus which is closely adjacent to the anterior adductor muscle scar, its lack of scissulate sculpture and its more highly polished anterior surface. The internal surface of the valves of *consobrina* often tends to be thickened, irregular and not highly polished. In the present consideration, *versicolor* and *consobrina* are much more distantly related than previously assumed.

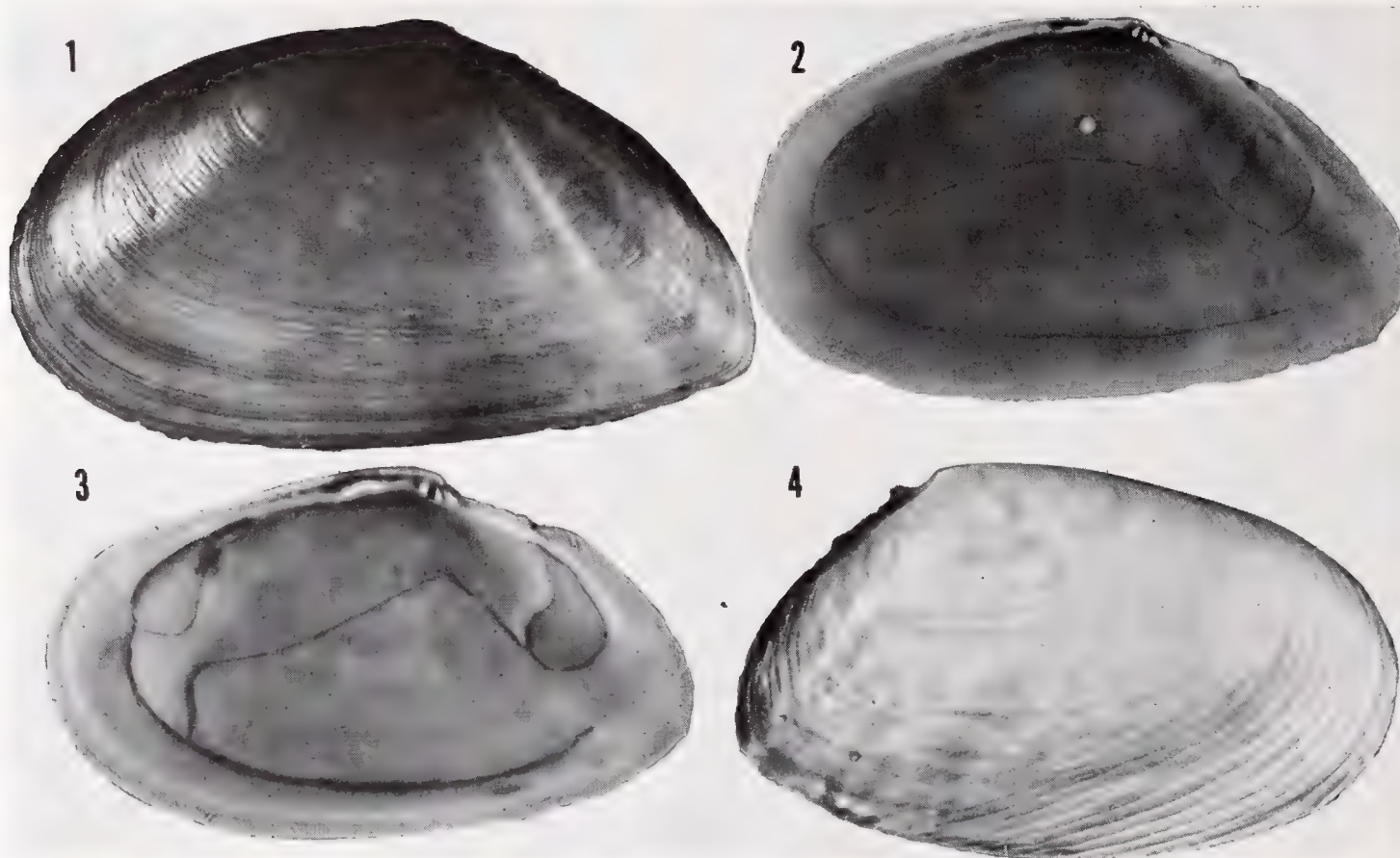


Plate 161. Figs. 1-2. *Tellina sandix* Boss. Fig. 1. External view of the left valve (about 4.7x) [L=17 mm.]. Fig. 2. Internal view of the right valve, Santa Barbara de Samana, MCZ 236333 (about 5.5x) [L=13 mm.]. Fig. 3. *Tellina consobrina* d'Orbigny, internal view of the right valve, off Fowey Light, Florida, USNM 462116 (about 5x) [L=14 mm.]. Fig. 4. *Tellina iris* Say, external view of the right valve, Fort Myers Beach, Florida, MCZ 243052 (about 7x) [L=10 mm.].

Tellina consobrina appears to be most closely related to *Tellina similis*. The acentric scissulate pattern of sculpture in *consobrina* is relatively obscure or obsolete when compared with the more closely set, well developed scissulations found in *similis*. No heavy and strongly developed concentric sculpture on the posterior slope of the right valve is differentiated in *consobrina*, whereas in *similis*, the presence of strong concentric sculpture in that area is diagnostic. In addition, the two species may be separated by the pallial sinus which in *consobrina* is higher and more distantly removed from the anterior adductor muscle scar.

Among the other species with which *Tellina consobrina* may be confused is *T. probrina*. The characters used to differentiate these two species have been discussed elsewhere (see *Remarks* under *T. probrina*).

Range. This species occurs from Miami, Florida through the Greater and Lesser Antilles to Tobago; it has also been discovered in Bermuda.

Specimens examined. FLORIDA: off Miami, in 24 fathoms; off Fowey Light, in 38–70 fathoms; Turtle Harbor; Key Largo; Key Vaca; Looe Key; Sambo Reef; Key West Channel; Dry Tortugas (all USNM). BERMUDA: Castle Rock (MCZ). CUBA: Cayo Arenas; Santa Lucia; Santa Rosa; Bahia Honda; Cabanas; Bahia de Cochinos (all USNM). PUERTO RICO: Mayagüez; La Parguera (both IMBPR); off Cape San Juan Light, in 26 fathoms (USNM). VIRGIN ISLANDS: St. Thomas (USNM). LESSER ANTILLES: Martinique (BMNH); English Harbour and Falmouth Harbour, Antigua; Barbados (all USNM); 2 miles S of Fort George, Scarborough, Tobago, in 36 fathoms (MCZ).

***Tellina (Scissula) iris* Say**

Plate 161, fig. 4

Tellina iris Say 1822, Jour. Acad. Nat. Sci., Philadelphia, 2: 302 (inhabits the southern shores) [type locality, here restricted, Sullivan's Island, South Carolina; holotype, ANSP 52375].

Tellina (Angulus) iris Say. H. and A. Adams 1856, Genera Recent Mollusca, 2: 397.

Tellina plagia Ravenel 1885, Proc. Elliot Soc., 2(5): 40 (on the beach near Charleston, South Carolina) [types lost].

Tellina (Scissula) iris Say. Dall 1900, Proc. U.S. Nat. Mus., 23: 291.

Tellina (Scissula) caribaea 'd'Orbigny' Dall 1900, Proc. U.S. Nat. Mus., 23: 297, *non* d'Orbigny 1842.

Tellina (Cirsula) irrus Say. Cary and Spaulding 1909, Bull. Gulf Biol. Sta., 12: 21, errors for *Scissula* and *iris*.

Description. Shell extending to 15.3 mm. (about $\frac{5}{8}$ inch) in length and to 9 mm. (about $\frac{3}{8}$ inch) in height, elongate, elliptical, thin, rather compressed with both valves of equal convexity and with or without a very weak flexure to the right. Umbos posterior to the middle, small and somewhat pointed. Anterior margin smooth and rather narrowly rounded; ventral margin long, more or less straight, and rising slightly posteriorly; anterior dorsal margin long, gently sloping and slightly convex; posterior dorsal margin long, straight to slightly convex, and forming a broad slightly oblique truncation. Sculpture consisting of closely set, poorly developed, concentric incremental lines which are most noticeable on the posterior slope. The concentric sculpture is intersected and crossed by well developed, widely spaced scissulations which descend across the shell at an angle of 20–30 degrees (about 4–6 per millimeter). No radial sculpture. Ligament light yellow brown, short, generally weak and slightly protuberant. Calcareous portion of the ligament subtended by flange-like, elevated nymphal callosities. In the left valve, the cardinal complex consists of an anterior, small, narrowly elongate and protuberant bifid tooth with subequal lobes and of a posterior thin, elongate laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior strongly skewed bifid tooth whose posterior lobe is the larger and of an anterior thickened laminate tooth; anterior lateral tooth proximal to the cardinal complex, thin and laminate; posterior lateral tooth absent or obsolete, consisting of a distal thickening of the hinge plate. Adductor muscle scars rather poorly impressed. Anterior adductor irregularly quadrate; posterior adductor somewhat rounded. Pallial sinus rises abruptly posteriorly, descends gently and unites in an arcuation with the pallial line below; confluence extensive. The pallial sinus is separated by about one millimeter from the anterior adductor. Shell transparent to translucent, often extremely fragile, predominantly white or clear, but with some suffusion of red or pink. Two prominent white rays often occur in the posterior quarter of the disc. Internally the shell is smooth and polished.

length	height	width	
15.3 mm.	9.0 mm.	—	South Carolina
13.0	6.3	2.5 mm.	Galveston, Texas
12.5	7.0	2.5	Sea Island, Georgia
9.0	5.8	2.0	St. Petersburg, Florida

Remarks. This species possesses a small iridescent shell not unlike that of *T. versicolor*, and it has probably been confused with the latter a number of times since the two species are sympatric over most of their ranges. However, *versicolor* is distinctly separated from *iris* in the lack of scissulations. *Tellina iris* has scissulations, but often these sulci are obscured or in part destroyed or worn away, especially in the region of the central disc; therefore, one must be extremely careful in examining specimens to insure a proper identification. Scissulations even on old and worn specimens may generally be discerned along the ventral margin or on the extreme anterior slope. In addition, the pallial sinus of *iris* is removed from the anterior adductor muscle scar whereas that of *versicolor* is closely adjacent to that scar.

In the Western Atlantic, *iris* is most closely related to *T. sandix* which has a more southerly range. The former is a smaller species with a much shorter posterior dorsal slope and without the total pink or red coloration of *sandix*; the sculpture of *iris* is also noticeably more widely spaced. In the Eastern Pacific, *Tellina virgo* represents the nearest relative to *iris* though *iris* has a smaller shell with more widely spaced sulci and a differently angled posterior ridge.

In the fossil record of the Western Atlantic, Dall (1900b) described *Tellina scitula* (*non* Meek and Hayden, 1827) which has been renamed *healyi* by Woodring (1925). Dall indicated that this species occurs in the Miocene of Santo Domingo and of Bowden, Jamaica. Maury (1917) found it in the formations at Cercado de Mao and Rio Cana which illustrate its range through the Lower Miocene. In contrast to *iris*, *healyi* has finer, more oblique sulci and its posterior end is more pointed. Woodring (1925) in his discussion on *healyi* noted the resemblance of this species to certain *Eurytellina* and also mentioned that specimens of *healyi* from Santo Domingo, when compared to Bowden specimens possessed a thinner shell and a more slender nymph.

Range. This species extends as far north as North Carolina, in the vicinity of Cape Hatteras, south through the lower Florida Keys and west along the Gulf coast to Galveston, Texas. The greatest recorded depth is 17 fathoms and the species seems to prefer the inshore shallow areas along beaches.

Specimens examined. NORTH CAROLINA: Cape Hatteras Point; off Cape Hatteras, in 14–17 fathoms (both USNM). SOUTH CAROLINA: Sullivan's Island; Charleston; Folly Beach (all CM). GEORGIA: Sea Island (MCZ); Cumberland Island (CM). FLORIDA: Mayport; St. Augustine; Daytona Beach (all MCZ); off Miami, in 3 fathoms; Bahia Honda Key; Dry Tortugas; Caximba Pass; Marco Island; Bunch Beach; Punta Rassa (all D. and N. Schmidt); Sanibel; Bradenton Beach; St. Petersburg (all MCZ). LOUISIANA: Cameron (USNM). TEXAS: Sabine (MCZ); Galveston (ANSP).

Tellina (Scissula) sandix, new name

Plate 161, figs. 1-2

Tellina exilis Lamarck 1818, Animaux s. Vertebres, 5: 527 (no locality given) [type locality, here restricted, Port Antonio, Jamaica; syntypes, Museum d'Histoire Naturelle, Geneva], *non* Meuschen 1787, *nec* Link 1808.

Tellina (Angulus) exilis Lamarck. H. and A. Adams 1856, Genera Recent Mollusca, 2: 397.

Tellina (Scissula) exilis Lamarck. Dall 1900, Proc. U.S. Nat. Mus., 23: 297.

Description. Shell extending to 19 mm. (about $\frac{3}{4}$ inch) in length and to 11 mm. (about $\frac{1}{2}$ inch) in height, elongate-subtrigonal, thin, fragile, compressed with both valves of equal convexity and with or without a very slight flexure to the right. Umbos posterior to middle, inconspicuous and rather blunt. Anterior margin smoothly and somewhat narrowly rounded; ventral margin nearly straight and rising only slightly posteriorly; anterior dorsal margin long, gently sloping, and convex; posterior dorsal margin long and rather steeply sloping; posterior margin short, ill defined, generally straight, and forming a small posterior truncation. Sculpture consisting of poorly defined, closely set concentric incremental bands which are intersected by closely set and finely incised scissulations (about 10 per millimeter) which cross at an angle of 30 degrees. No radial sculpture present. Ligament brown, rather short, weak and not protuberant. Calcareous portion of the ligament subtended by short, but slightly raised nymphal callosities. In the left valve, the cardinal complex consists of an anterior narrow, elongate, deeply cleft bifid tooth with equal lobes and of a posterior divergent, extremely long and thin laminate tooth; no true lateral dentition present. In the right valve, the cardinal complex consists of a posterior, strongly skewed, well developed bifid tooth whose posterior lobe is much the larger and of an anterior, variously developed laminate tooth; anterior lateral tooth proximal to the cardinal complex, long, thin and laminate; posterior lateral tooth absent or obsolete, consisting of a distal thickening of the hinge plate. Adductor muscle scars moderately well impressed. Anterior adductor irregularly elongate; posterior adductor round. Pallial sinus rising rather abruptly posteriorly, extending almost to, but not confluent with the anterior adductor, descending gently and arcuately falling to the pallial line; confluence complete. Shell transparent, translucent, predominately crimson suffused with pink or white, often with white rays posteriorly. Rarely iridescent. The internal surface is shining, but not highly polished.

length	height	width	
15.6 mm.	9.2 mm.	3.2 mm.	Syntype of <i>exilis</i> Lamarck
19.0	11.0	—	Monte Cristi, Santo Domingo
17.2	10.2	3.3	Guadeloupe
14.5	10.5	—	"
12.0	8.0	—	Jamaica

Remarks. This species has often been confused with the more northerly *Tellina iris* Say to which it is very closely allied. The scissulations of *sandix* number about 10 per millimeter whereas in *iris* they are more widely spaced, numbering about 4-6 per millimeter. The angle of descent of the sulci across the surface of the valves is nearly the same in both species. In color, *sandix* is nearly always pink or red with some indication of colored rays posteriorly while *iris* is usually white and its posterior rays may be poorly or well developed. The descent of the posterior dorsal slope is especially diagnostic in *sandix* and serves to differentiate *iris* as well. In *sandix*, this slope is characteristically

elongate and somewhat steeply inclined, giving the posterior portion a produced appearance whereas the posterior slope in *iris* is markedly shorter and more steeply inclined. The pallial sinus of *iris* is typically further removed from the anterior adductor muscle scar than it is in *sandix*.

Among the variations exhibited by *Tellina sandix*, none seems as important as the thickness of the valves; some specimens are heavier than others, being opaque rather than completely translucent or even at times transparent. The extreme thinness of the valves makes them relatively fragile.

According to Dall (1900a), *Tellina sandix* is related to the Eastern Pacific species, *Tellina virgo* Hanley, and they may be separated in that the former is more compressed, more arcuate and less pointed behind. However, *T. esmeralda* Olsson seems even more closely allied to *sandix* than *virgo*, and the latter may, in turn, be considered closely related to *iris* (see *Remarks* under *iris*). In the Tertiary of the Western Atlantic, there does not seem to be any obvious precursor to *sandix*.

Range. This species appears to possess a distribution that is distinctly Antillean and South American. Although Aguayo and Jaume list this species in their catalog of the mollusks of Cuba, the northernmost record which is preserved in the museums in this country is from Jamaica. Excluding Cuba, the range of this species extends from the Greater Antilles, through the Lesser Antilles, and along the South American coast to Uruguay.

Specimens examined. JAMAICA: Port Antonio; Port Morant (both MCZ). HISPANIOLA. HAITI: Baie Anglaise; Aquin (both USNM). SANTO DOMINGO: Monte Cristi; Santa Barbara de Samana (both MCZ). PUERTO RICO: Isla Desecheo; Punta Guanajibo (both IMBPR). LESSER ANTILLES: Guadeloupe (ANSP; MCZ). BRASIL: Thayer Expedition (MCZ); Santos (USNM). URUGUAY: La Paloma Rocha (USNM).

***Tellina (Scissula) candeana* d'Orbigny**

Plate 162, fig. 2

Tellina candeana d'Orbigny 1842 [in] Sagra, Hist. L'Ile Cuba, Atlas, pl. 25, figs. 50-52; 1845, Spanish Text, 2(5): 303 (Martinica); 1853, French Text, Mollusques, 2: 254 [lectotype, here selected and figured, BMNH 54.10.4.503].

Tellina (Scissula) candeana d'Orbigny. Dall 1900, Proc. U.S. Nat. Mus., 23: 297.

Tellina (Anbulus) candeana d'Orbigny. McLean 1951, New York Acad. Sci., 17(1): 97, pl. 20, fig. 2 (error for *Angulus*).

Description. Shell extending to 16 mm. (about $\frac{5}{8}$ inch) in length and to 10 mm. (about $\frac{3}{8}$ inch) in height, elongate-subtrigonal, inflated with the left valve of greater convexity and with a strong posterior flexure to the right. Umbos posterior to the middle, opisthogyrous and blunt. Anterior margin smoothly and narrowly rounded; ventral margin convex and rising gently in the posterior arcuation; anterior dorsal margin very long, gently sloping, more or less straight; posterior dorsal margin long, steeply sloping and straight; posterior margin rather ill defined, straight and forming an oblique truncation. Sculpture consisting of closely set, raised concentric lirations limited to the posterior slope; the disc of the shell and the anterior slope are covered with closely set scissulations (about 7-8 per millimeter) which descend obliquely across the surface of the shell at an

angle of about 50 degrees. No radial sculpture present. Ligament light brown, short, rather weak and slightly protuberant. Nymphal plate without raised callosities. In the left valve, the cardinal complex consists of an anterior narrow and elongate bifid tooth with subequal lobes and of a posterior thin, laminate tooth; no true lateral teeth present. In the right valve, the cardinal complex consists of a posterior, slightly skewed bifid tooth whose posterior lobe is the larger and of an anterior, somewhat thickened laminate tooth; anterior lateral tooth strong, proximal to the cardinal complex, elongate and laminate; the posterior lateral tooth is distal to the cardinal complex, small, pointed and variously developed though never as strong as the anterior lateral. Adductor muscle scars fairly well impressed. The anterior adductor quadrate; the posterior adductor round. Pallial sinus equal in both valves, rising slightly posteriorly to a blunt apex, descending gently and falling arcuately to the pallial line; confluence extensive. The pallial sinus is separated from the anterior adductor by about 0.5 mm. The shell is smooth, shining, white, and often suffused with yellow or pink; the suffusion may be localized on the disc or include the entire valve. Internally, smooth and rather highly polished, white, or with yellow or pink suffusions.

length	height	width	
10.5 mm.	8.0 mm.	3.8 mm.	Lectotype of <i>candeana</i> d'Orb.
16.0	10.0	5.0	Turks Island, Bahamas
14.0	8.5	4.5	Grassy Key, Florida
12.0	8.1	3.5	Santa Rosa, Cuba
8.2	5.5	2.8	Grand Cayman Island

Remarks. This species, as evidenced by the measurements, possesses some variability with regard to shape, but in outline, the shell always appears to be subtrigonal. In color, *candeana* is predominantly white but occasionally specimens which are completely pink are encountered. The usual coloration in young individuals is white with umbonal suffusions of yellow or yellow-green. From the basic morphological pattern of *Scissula*, *candeana* is divergent, and there is some evidence, particularly in the strength of the right posterior lateral tooth, that may indicate that the species could be removed from the scissulate group. However, the thickness of the shell, the angle of the descent of the oblique sulci and the character of the pallial sinus present evidence that *candeana* is related to *similis*. Among other characters, these species may be separated most easily on

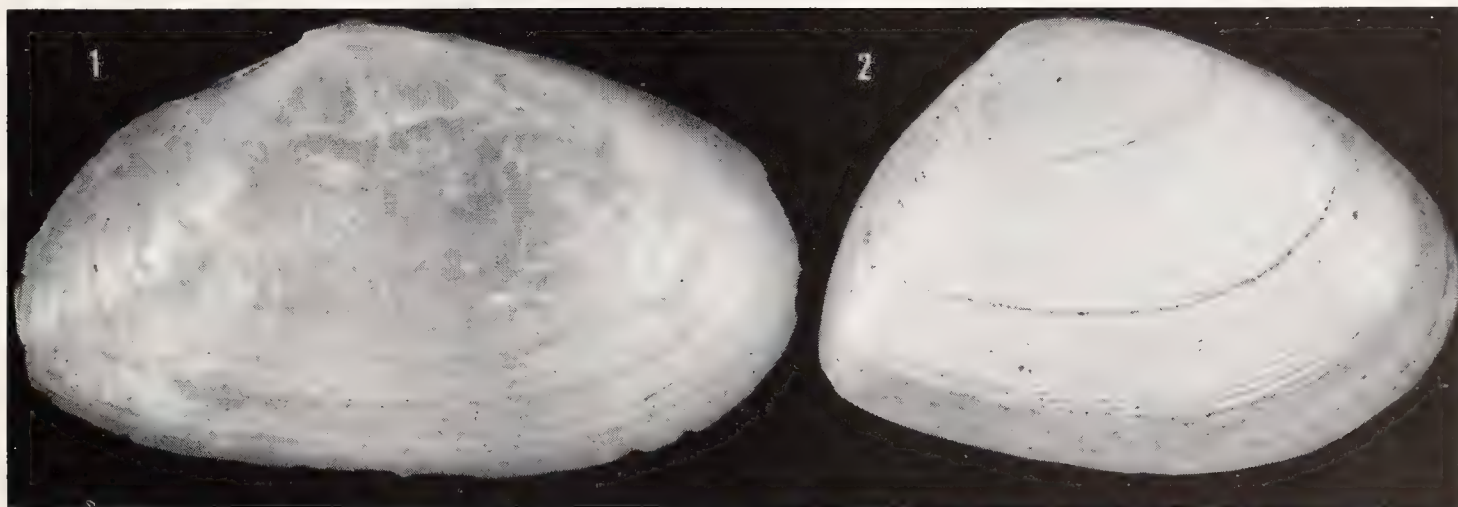


Plate 162. Fig. 1. *Tellina consobrina* d'Orbigny, external view of the right valve of the syntype, Martinique, BMNH (about 6.3x) [L=12.3 mm.]. Fig. 2. *Tellina candeana* d'Orbigny, external view of the right valve of the lectotype, Martinique, BMNH (about 6x) [L=10.5 mm.].

shape alone, where *similis* is subquadrate and *candeana* is subtrigonal. There are no species in the Eastern Pacific with which *candeana* could be closely related or confused. In the fossil record of the Western Atlantic, *Tellina calliglypta* Dall seems most closely allied to *candeana* and Olsson and Harbison (1953) have recorded the occurrence of the latter in the Pliocene of Florida. Rehder (1962) has listed *candeana* from the Pleistocene deposits on Grand Cayman Island.

Robertson (1959) has described the habitat of this species in the Bahamas. Usually, the species occurs among the rhizomes of *Thalassia*, but sometimes it may be found in sand substrates which are devoid of large plants. He also found large numbers of dead specimens of *candeana* in mud substrates at the northern end of North Sound, Bimini. The greatest depth recorded for this species is 6 fathoms, and Abbott (1958) has given its depth range at Grand Cayman as being between 6 and 25 feet.

Range. The northernmost continental extension of the range of this species is the southeastern coast of Florida, off Palm Beach; it is found in Bermuda, through the Bahamas, and south through the Lesser Antilles to Guadeloupe.

Specimens examined. FLORIDA: off Palm Beach (MCZ); off Miami; off Caesar's Creek Bank (both USNM); Grassy Key; Key Vaca (both D. and N. Schmidt); New-found Harbor Key; Key West; Boca Grande Key; Cedar Key (all USNM). BERMUDA: Castle Island (USNM); Castle Rock; North Rock, in 4 fathoms (both MCZ). BAHAMA ISLANDS: Bimini (MCZ); Cat Cay; off Mintie Bar, Andros; New Providence (all USNM); Governor's Harbour and Savannah Sound, Eleuthera; Orange Creek and Camptown, Cat Island; Little San Salvador; Simms, Long Island; Turks Island (all MCZ). CUBA: Cayo Levisa; Santa Rosa (both USNM); La Sortija, Caibarien; Guarda la Vaca, Banes, Oriente (both MCZ). VIRGIN ISLANDS: Anegada; St. Thomas; St. Croix (all ANSP). LESSER ANTILLES: Martinique (BMNH); Guadeloupe (MCZ). CARIBBEAN ISLANDS: Gun Bay, West Beach, and Frank Sound, Grand Cayman (all ANSP).

Genus *Tellidora* H. and A. Adams

Tellidora (Mörch MS) H. and A. Adams 1856, *Genera Recent Mollusca*, 2: 401 (type species, *Tellina burneti* Broderip and Sowerby 1829, subsequent designation Stoliczka, 1870, p. 116).

Tellipiura Olsson 1944, *Bull. Amer. Paleo.*, Ithaca, N.Y., 28: 221 (type species, *Tellidora* (*Tellipiura*) *peruana* Olsson 1944, original designation).

Description. Shell of medium size, trigonal, valves of unequal convexity, relatively thin, more or less equilateral, somewhat compressed; umbos high and centrally located; dorsal margin in distinct anterior and posterior portions both of which are spinose; two cardinal teeth in each valve, one bifid and one laminate; two lateral teeth in each valve, stronger in the right valve; surface of the valves more or less smooth but with growth lines and concentric sculpture. Ligament immersed and relatively short. Pallial sinus extensive, ascendant and nearly half of its lower margin confluent with the pallial line.

As has been noted by Dall (1900) and Olsson and Harbison (1953), the generic name *Tellidora* has often been attributed to Mörch, as indeed it had been by H. and A. Adams; however, there is no published usage of this name by Mörch prior to 1856. Two Recent species of this genus occur, one in the Western Atlantic region and another in the Eastern Pacific. Adams described two species, *pellyana* from the Persian Gulf

and *pusilla* from the Red Sea which he assigned to *Tellidora* but both appear to belong to *Merisca* or another related group.

***Tellidora cristata* (Recluz)**

Plate 163, figs. 1-2

Lucina cristata Recluz 1842, Revue Zool. Societ  Cuvier., 5: 270 (Campeche Banks); Guerin 1843, Mag. de Zool., pl. 60, 5 figs. [types not seen].

Tellidora (*Tellina*) *lunulata* H. and A. Adams 1856, Genera Recent Mollusca, 2: 401 [types not seen].

Tellidora lunulata H. and A. Adams [in] Holmes 1860, Post-Pleiocene Fossils of South Carolina, p. 47, pl. 9, figs. 7-7d (St. Andrews, South Carolina).

Tellidora cristata Recluz. Dall 1889, Bull. No. 37, U.S. Nat. Mus., p. 62.

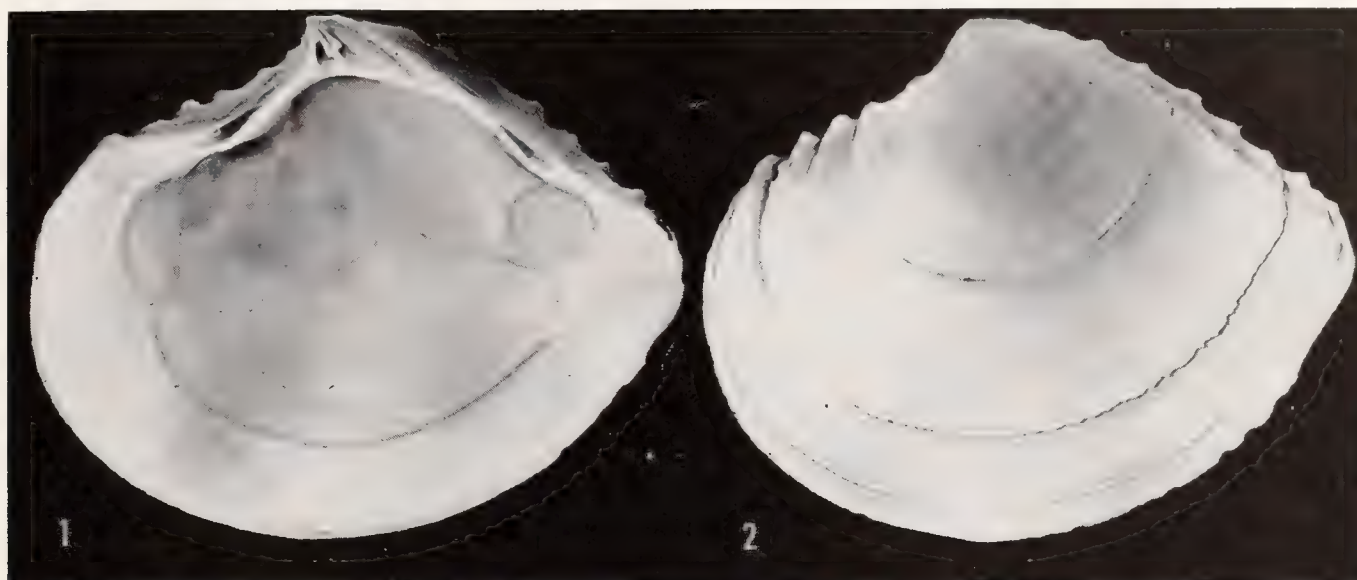


Plate 163. *Tellidora cristata* (Recluz). Fig. 1. Internal view of the right valve. Fig. 2. External view of the left valve, Progreso, Yucatan, MCZ 23589 (about 1.8x) [L=37 mm.].

Description. Shell reaching 37 mm. (about 1½ inches) in length and 30 mm. (about 1¼ inches) in height, subtrigonal, subsolid, compressed, without or with only a slight posterior flexure to the right and with the valves thin to fragile in immature stages. The left valve is much flattened and the right valve is tumid and convex. Umbos central, acute and elevated. Anterior margin broadly rounded; ventral margin rounded, rising posteriorly in an arcuation; posterior margin straight, extremely short and forming a truncation. Anterior and posterior dorsal margins with triangular spinosities. Sculpture consisting of strong narrow ridges somewhat irregularly and broadly spaced and not raised in older specimens. Ligament light brown, short and partially internal. The spines of the dorsal margin form a deep lunule and escutcheon. In the left valve, the posterior single laminate cardinal tooth generally weak and tending to become obsolete; anterior cardinal tooth weakly bifid; both lateral teeth distal to the cardinal complex. In the right valve, the single anterior laminate cardinal tooth narrow and weak in young specimens, obsolete in adults; posterior bifid cardinal tooth long and narrow; posterior lateral tooth distal to the cardinal complex and well developed but weaker than the strong, subproximal anterior lateral tooth. Adductor muscle scars well impressed. Anterior and posterior adductor muscle scars subequal; posterior scar nearly rounded. Pallial sinus similar in both valves, short, widely separated from the anterior adductor scar, falling arcuately to the pallial line and uniting with it posteriorly. The shell and umbo are milk-white internally and externally.

length	height	width	
36.8 mm.	29.0 mm.	6.5 mm.	Progreso, Yucatan
29.0	22.9	5.5	Cortez, Florida
26.7	20.2	4.2	Sanibel Island, Florida
13.0	10.2	2.2	Little Marco Island, Florida

Remarks. This species is the only living member of the genus in the Western Atlantic, and as such is easily recognized. Its peculiar trigonal shape combined with the dorsal extensions of the concentric sculpture immediately separate it from other species. Its nearest relative and closest ally, *Tellidora burneti*, occurs in the Eastern Pacific. From this species *cristata* may be distinguished by its convex right valve, flattened left valve, lower proportions and less convex anterior dorsal margin. It is interesting to note that the convexity and concavity of the valves in *burneti* is directly opposite in *cristata*; in *burneti*, the right valve is much flattened and noticeably concave whereas the left valve is convex.

Tellidora cristata is represented in the fossil history of the Western Atlantic by what has been called *Tellidora lunulata* 'Holmes' H. and A. Adams. This Pliocene and Pleistocene fossil is considered to be a synonym of the Recent species following the treatment by Dall (1900a). It has been recorded in the Pliocene and Pleistocene strata of Florida, the Carolinas and the Gulf Coast States.

This species is a shallow water form and Parker (1960) has delineated it in the inlet and deep channel faunal assemblages in the northern Gulf of Mexico. It prefers a bottom type which is predominantly sandy, at depths ranging from 8 to 45 feet.

Range. This species is found from Beaufort, North Carolina to the Florida Keys and along the Gulf Coast to Yucatan, Mexico.

Specimens examined. NORTH CAROLINA: Beaufort (USNM). SOUTH CAROLINA: Isle of Palms (CM). FLORIDA: Fort George; Key Largo; Pine Key; Cape Romano (all USNM); Little Marco Island; Sanibel; Tarpon Bay; Charlotte Harbor; Lemon Bay; Siesta Key; Cortez; Gulfport; Sea Horse Key, Cedar Keys (all MCZ). ALABAMA: Fort Morgan (MCZ). LOUISIANA: Santa Rosa Sound (USNM). TEXAS: Pass Cabello (USNM); Port Aransas (MCZ). MEXICO: Campeche (ANSP); Progreso, Yucatan (MCZ).

BIBLIOGRAPHY

- Abbott, R.T. 1958. The marine mollusks of Grand Cayman Island, British West Indies. Acad. Nat. Sci. Philadelphia, Monograph 11, 138 pp., 5 pls.
- Adams, H. and A. Adams. 1856. The genera of Recent Mollusca, London, 2: 388-403.
- Afshar, F.A. 1950. Taxonomic revision of the Cretaceous and Cenozoic Tellinidae. Unpublished Ph.D. Dissertation, Johns Hopkins University, Baltimore, 137 pp.
- Atkins, D. 1937a. On the ciliary mechanisms and interrelationships of lamellibranchs. Pt. 2. Quart. Jour. Micro. Sci., 79: 339-373.
- Atkins, D. 1937b. On the ciliary mechanisms and interrelationships of lamellibranchs. Pt. 3. Quart. Jour. Micro. Sci., 79: 375-421.
- Barrois, T. 1885. Les glandes du pied et les pores aquifères chez les lamellibranches. Danel, Paris, 169 pp.
- Bartsch, P. 1933. Station records of the first Johnson-Smithsonian deep-sea expedition. Smith. Misc. Coll., 91(1): 1-31.
- Bertin, V. 1878. Révision des Tellinides. Nouv. Arch. Mus., Paris, ser. 2, 1: 201-361, pls. vii and ix.
- Born, I. 1778. Index rerum naturalium Musei Caesarei Vindobonensis. Pt. 1. Testacea. Vienna. 458 pp., 1 pl.
- Born, I. 1780. Testacea Musei Caesarei Vindobonensis. Vienna, 442 pp., 18 pls.
- Boss, K.J. and V.C. Kenk. 1964. Anatomy and relationships of *Temnoconcha brasiliensis* Dall. Occ. Papers Dept. Mollusks, Harvard University, 2(30): 325-344, pls. 56-60.
- Carrière, J. 1879. Über die Drüsen im Fuss der Lamellibranchiaten. Arbeit. Zool. Inst. Würzburg, 5: 56-92.
- Children, J.G. 1823. Lamarck's Genera of Shells. Quart. Jour. Sci., Lit., and Arts, 14: 32.
- Coomans, H.E. 1962. The marine mollusk fauna of the Virginian area as a basis for defining zoogeographical provinces. Beaufortia, 9: 83-104.
- Cossmann, M. 1886. Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Ann. Soc. Roy. Mal. Belg., 21: 68-99.
- Dall, W.H. 1881. Preliminary report on the Mollusca [Blake]. Bull. Mus. Comp. Zool., Harvard College, 9(2): 33-144.
- Dall, W.H. 1889. A preliminary catalogue of the shellbearing marine mollusks and brachiopods of the southeastern coast of the United States. U.S. Nat. Mus., Bull. No. 37, 212 pp., 74 pls.
- Dall, W.H. 1900a. Synopsis of the family Tellinidae and of the North American species. U.S. Nat. Mus., 23: 285-326, pls. 2-4.
- Dall, W.H. 1900b. Tertiary fauna of Florida. Transactions of the Wagner Free Institute of Science of Philadelphia, 3(5): 1002-1039.
- Dall, W.H. and C.T. Simpson. 1901. The Mollusca of Porto Rico. U.S. Fish. Comm., Bull., 20(1): 351-524.
- Dall, W.H., P. Bartsch, and H.A. Rehder. 1938. A manual of the Hawaiian Islands. Bull. Bishop Museum, Honolulu, No. 153, 230 pp., 58 pls.
- Deshayes, G.P. Exploration scientifique de l'Algérie . . . 1840-42, Paris. Zoologie, vol. 1. Histoire naturelle des Mollusques, pp. xx, 609. Atlas, pp. 160, 155 pls.
- Dodge, H. 1947. Lamarck's Prodrome d'une nouvelle classification des coquilles. Nautilus, 60(1): 26-31; 61(2): 60-70; 61(4): 134-143.
- Dodge, H. 1952. A historical review of the mollusks of Linnaeus. Part 1. The Classes Loricata and Pelecypoda. Bull. Amer. Nat. Hist., New York, 100(1): 1-264.
- Duvernoy, M. 1853. Mémoires sur le système nerveux des Mollusques Acepheles. Mém. Acad. Sci., Paris, 24: 3-312.
- Ekman, S. 1953. Zoogeography of the sea. Sedgwick and Jackson Ltd., London.
- Figueiras, A. 1962. Sobre nuevos hallazgos de Moluscos subfósiles de la transgresión querandina. Comunicaciones Soc. Mala. Uruguay, 1(3): 53-68.
- Fischer, P. 1887. Manuel de Conchyliologie. Paris, 1369 pp., 1158 text figs., 23 pls.

- Gardner, J.A. 1928. The molluscan fauna of the Alum Bluff Group of Florida. U.S. Geol. Sur., Prof. Paper 142 A-I, Pt. 5, Chapter E, Tellinacea . . . , pp. 185-249.
- Graham, A. 1934a. The cruciform muscle of lamellibranchs. Proc. Roy. Soc. Edinb., **54**: 17-30.
- Graham, A. 1934b. The structure and relationships of lamellibranchs possessing a cruciform muscle. Proc. Roy. Soc. Edinb., **54**: 158-187.
- Graham, A. 1937. On the ciliary currents on the gills of some Tellinacea (Lamellibranchiata). Proc. Roy. Soc. Edinb., **57**: 128-134.
- Graham, A. 1949. The molluscan stomach. Trans. Roy. Soc. Edinb., **61**(3): 737-778.
- Gray, J.E. 1847. A list of the genera of Recent Mollusca, their synonyms and types. Proc. Zool. Soc. London, **15**: 129-219.
- Gualtieri, N. 1742. Index testarum conchyliorum quae adservantur in Museo Gualtieri. Florence, 23 pp., 110 pls.
- Hanley, S. 1846. A monograph of the genus *Tellina*. [in] Sowerby, Thesaurus Conchyliorum, **1**: 221-336, pls. 57-66.
- Hanley, S. 1855. Ipsa Linnaei Conchylia. The shells of Linnaeus determined from his manuscripts and collections. London, 556 pp., 5 pls.
- Herrmannsen, A.N. 1846-49. Indicis generum malacozoorum primordia. Cassellis, vol. 1 (1846-47), 637 pp.; vol. 2 (1847-49), 717 pp.
- Hertlein, L.G. and A.M. Strong. 1949. Eastern Pacific expeditions of the New York Zoological Society. Mollusks from the west coast of Mexico and Central America. Part VII. Zoologica, **34**(2): 63-97, 1 pl.
- Hoffmann, F. 1914. Beiträge zur Anatomie und Histologie von *Tagelus dombeyi* (Lamarck). Jena Zeit. Naturw., **52**: 521-561.
- Holmes, F.S. 1860. Post-Pleiocene fossils of South Carolina. Charleston, S.C., 128 pp., 28 pls.
- Ihering, H. von. 1876. Die Gehörwerkzeuge der Mollusken in ihrer Bedeutung für das natürliche System. Erlangen, Habilitationsschrift, 33 pp.
- Ihering, H. von. 1901. The musculus cruciformis of the order Tellinacea. Proc. Acad. Nat. Sci. Philadelphia, pp. 480-481.
- Ihering, H. von. 1907. Les mollusques fossiles du Tertiaire et du Crétacé Supérieur de l'Argentine. Anales del Museo Nacional de Buenos Aires, **14** (ser. 3), **7**: 1-611.
- Ihering, H. von. 1927. Die Geschichte des Atlantischen Ozeans. Jena, 237 pp.
- Jeffreys, J.G. 1863. British Conchology, London, vol. 3, 393 pp., 8 pls.
- Johnson, C.W. 1932. Some notes on the New England species of *Tellina*. Nautilus, **45**(4): 109-111.
- Johnson, C.W. 1934. List of marine Mollusca of the Atlantic coast from Labrador to Texas. Proc. Boston Soc. Nat. Hist., **40**(1): 1-204.
- Keen, A.M. 1958. Sea shells of tropical west America. Stanford Univ. Press, 624 pp., 10 color plates, 1709 figs.
- Kellogg, J.L. 1915. Ciliary mechanisms of lamellibranchs with descriptions of anatomy. Jour. Morph., **26**: 625-701.
- Kennard, A.S., A.E. Salisbury and B.B. Woodward. 1931. The types of Lamarck's Genera of Shells as selected by J.G. Children in 1823. Smith. Misc. Coll., **82**(17): 1-40.
- Kobelt, W. 1876-1881. Illustriertes conchylienbuch. Nürnberg. 391 pp. (see Rehder, H. 1952. Nautilus, **6**: 59-60).
- Lamarck, J.B. 1799. Prodrome d'une nouvelle classification des coquilles. Mém. Soc. Hist. Nat. Paris, pp. 63-90.
- Lamarck, J.B. 1801. Système des animaux sans vertèbres ou tableau general des classes, des orders et des genres de ces animaux. Paris, 432 pp.
- Lamarck, J.B. 1818. Histoire naturelle des animaux sans vertèbres. Paris, **5**: 519-535.
- Lister, M. 1678. Historiae Animalium Angliae. London, 250 pp., 9 pls.
- Lister, M. 1770. Historiae sive synopsis methodicae conchyliorum. Editio Altera. Oxonii.

- Lovén, S. 1848. Beiträge zur Kenntniss der Entwicklung der Mollusca Acephala Lamellibranchiata. Stockholm, 39 pp., 15 pls.
- Lynge, H. 1909. The Danish Expedition to Siam 1899-1900. IV. Marine Lamellibranchiata. D.Kon. Dansk. Viden. Selsk. Skrift., Kobenhavn, 7 Raekke, Natur. og Math., Afdel. 5, no. 3, pp. 97-299, 5 pls., 1 map.
- Magalhaes, J. and S. Mezzalira. 1953. Moluscos fosseis do Brasil. Biblioteca Cientifica Brasileira, Ser. A-IV, 283 pp., 94 pls.
- Mansfield, W.C. 1932. Miocene pelecypods of the Choctawhatchee Formation of Florida. Florida State Geol. Sur., Bull. 8, 164 pp., 34 pls.
- Mansfield, W.C. 1938. Mollusks of the Tampa and Suwannee Limestones of Florida. Geological Bull. 15, Florida Dept. of Conservation, 282 pp., 21 pls.
- Maury, C.J. 1917. Santo Domingo type sections and fossils. Bull. Amer. Paleontology, 5(29): 419-459.
- Maury, C.J. 1920. Recent Mollusca of the Gulf of Mexico and Pleistocene and Pliocene species from the Gulf States. Pt. 1. Pelecypoda. Bull. Amer. Paleontology, 8(34): 33-148.
- Maury, C.J. 1925. A further contribution to the paleontology of Trinidad. Bull. Amer. Paleontology, 10(42): 152-402.
- Maury, C.J. 1934. Fossil invertebrata from NE Brasil. Bull. Amer. Mus. Nat. Hist., 67(4): 123-179.
- Mazyck, W.G. 1913. Catalogue of Mollusca of South Carolina. Contrib. No. 2, Charleston Museum, 39 pp.
- McLean, R.A. 1951. The pelecypoda or bivalve mollusks of Porto Rico and the Virgin Islands. Scientific Survey of Porto Rico and the Virgin Islands. New York Acad. Sci., 17(1): 1-183.
- Megerle von Mühlfeld, J.D. 1811. Entwurf eines neuen Systems der Schalthiergehause. Gesellschaft Naturforschender Freunde Berlin, Magazin, 5: 38-72.
- Melvill, J.C. and R. Standen. 1907. The Mollusca of the Persian Gulf, Gulf of Oman, and Arabian Sea. Proc. Zool. Soc. London, pp. 783-848.
- Moore, H.B. 1930. The specific identification of faecal pellets. Jour. Mar. Biol. Assoc. U.K., 17: 359-365.
- Moore, H.B. 1931. The systematic value of a study of molluscan faeces. Proc. malac. Soc. London, 19: 281-290.
- Odhner, N. 1912. Morphologische und phylogenetische Untersuchungen über die Nephridien der Lamellibranchien. Zeit. wissen. Zool., 100(2): 287-391.
- Odhner, N. 1914. Notizen über die Fauna der Adria bei Rovigno. Zool. Anz., 44: 156-170.
- Olsson, A.A. 1961. Mollusks of the Tropical Eastern Pacific. Panamic-Pacific Pelecypoda. Paleontological Research Inst., Ithaca, N.Y., 574 pp., 86 pls.
- Olsson, A.A. and A. Harbison. 1953. Pliocene Mollusca of southern Florida. Acad. Nat. Sci. Philadelphia, Monograph 8, Pt. 1, 361 pp.
- Olsson, A.A. and T. McGinty. 1958. Recent marine mollusks from the Caribbean coast of Panama. Bull. Amer. Paleontology, 39(177): 1-58, 5 pls.
- Owen, G. 1955. Observations on the stomach and digestive diverticula of the Lamellibranchia. 1. The Anisomyaria and Eulamellibranchia. Quart. Jour. Micro. Sci., 96(4): 517-537.
- Paetel, F. 1890. Catalog der Conchylien-Sammlung. Berlin, vol. 3.
- Parker, R.H. 1956. Macro-invertebrate assemblages as indicators of sedimentary environments in east Mississippi delta region. Bull. Amer. Assoc. Pet. Geol., 40(2): 295-376.
- Parker, R.H. 1960. Ecology and distributional patterns of macroinvertebrates, northern Gulf of Mexico. Recent Sediments, Northwest Gulf of Mexico, 1951-1958. Published by the Amer. Assoc. Pet. Geol., Tulsa, pp. 302-381.
- Peile, A.J. 1926. The mollusca of Bermuda. Proc. malac. Soc. London, 17: 71-98.
- Pelseneer, P. 1911. Les lamellibranches de l'expédition du Siboga. Partie Anatomique. Leiden, 125 pp., 25 pls.
- Poli, I.X. 1795. Testacea Utriusque Siciliae. Parma, vol. 1.
- Purchon, R.D. 1960. The stomach in the Eulamellibranchia; Stomach Types IV and V. Proc. Zool. Soc. London, 135(3): 531-489.

- Ravenel, E. 1885. Tellinidae of South Carolina. Proc. Elliot Society, **2**(5): 33-40.
- Rees, C.B. 1950. Identification and classification of lamellibranch larvae. Hull Bull. Mar. Ecology, **3**(19): 73-104.
- Rehder, H.A. 1962. The Pleistocene mollusks of Grand Cayman Island with notes on the geology of the islands. Jour. of Paleo., **36**(3): 583-585.
- Richards, H.G. 1962. Studies on the marine Pleistocene, Pts. I and II, Trans. Amer. Phil. Soc. Philadelphia, New Ser., **52**(3): 5-141, 21 pls.
- Ridewood, W.G. 1903. On the structure of the gills of the Lamellibranchia. Phil. Trans. Roy. Soc. London, Ser. B, **195**: 147-284.
- Robertson, R. 1959. Marine mollusks of Bimini, Bahama Islands. Unpublished Ph.D. Dissertation, Harvard University, 294 pp.
- Romer, E. 1870-1873. Die Familie der Tellmuscheln, Tellinidae. [in] Martini-Chemnitz, Conchilien-Cabinet [sic] (2), **10**(4): 1-291, 52 pls.
- Salisbury, A.E. 1934. On the nomenclature of Tellinidae. Proc. malac. Soc. London, **21**(2): 74-91, pls. 9-14.
- Schmidt, F.C. 1818. Versuch der Conchylien-Sammlungen. Gotha, 252 pp.
- Smith, E.A. 1890. On the marine Mollusca of St. Helena. Proc. Zool. Soc. London, pp. 247-322.
- Sowerby, G.B. 1869. [in] Reeve, Conchologia Iconica, **17**, *Tellina*, 58 pls.
- Spengler, L. 1798. Over det toskallede slaegt tellinerne. Skrivter af Naturhistorie Selskabet, Kobenhavn, **4**(2): 67-127.
- Stoliczka, F. 1870-1871. Memoirs Geol. Survey India. Palaeontologia Indica. Cretaceous Fauna of southern India, **3**: 1-537.
- Sullivan, C.M. 1948. Bivalve larvae of Malpeque Bay, Prince Edward Id. Res. Board, Canada, Bull. 77, 36 pp.
- Thiele, J. 1935. Handbuch der systematischen Weichtierkunde. Jena, **2**: 779-1154.
- Trueman, E.R. 1942. The structure and deposition of the shell of *Tellina tenuis*. Jour. Roy. Micro. Soc., **62**: 69-92.
- Trueman, E.R. 1949. The ligament of *Tellina tenuis*. Proc. Zool. Soc. London, **119**(3): 717-742.
- Tryon, G.W. 1869. Catalogue of synonymy of the genera, species and varieties of Recent Mollusca. Pt. 2. American Jour. Conch., **4**: 72-106.
- Tuomey, M. and F.S. Holmes. 1857. Pleiocene Fossils of South Carolina. Charleston, S.C., 152 pp., 30 pls.
- Verrill, A.E. and K.J. Bush. 1898. Revision of the deepwater Mollusca of the Atlantic coast of North America. Pt. 1 Bivalvia. Proc. U.S. Nat. Mus., **20**: 775-901, pls. 71-97.
- Warmke, G.L. and R.T. Abbott. 1961. Caribbean Seashells. Narberth, Pennsylvania, 346 pp., 44 pls.
- White, K.M. 1942. The pericardial cavity and the pericardial gland of the Lamellibranchia. Proc. malac. Soc. London, **25**: 37-88.
- Woodring, W.P. 1925. Miocene mollusks from Bowden, Jamaica. Pelecypods and Scaphopods. Carnegie Inst. Washington, Publ. No. 366, 222 pp., 28 pls.
- Woodring, W.P. 1954. Caribbean land and sea through the ages. Geol. Soc. Amer., Bull. 65, **8**: 719-732.
- Yonge, C.M. 1949. On the structure and adaptations of the Tellinacea. Phil. Trans. Roy. Soc. London, Ser. B, No. 609, **234**: 29-76.

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TELLINIDAE

VOL. 4, NO. 47

THE SUBFAMILY TELLININAE IN THE WESTERN ATLANTIC

THE GENUS STRIGILLA

BY

KENNETH J. BOSS

The genus *Strigilla*, a distinctive element of the family Tellinidae, has a discontinuous distribution in the shallow, tropical-subtropical seas of the world and is represented in the fauna of the African Eastern Atlantic, the Indo-Pacific, the Western Atlantic, and the Eastern Pacific regions. The zone of the greatest concentration of species is the Caribbean-Eastern Pacific area. In the West African province, there is a single relict species of the subgenus *Aeretica*, whereas in the Indo-Pacific region, several species of *Aeretica* and a few of the subgenus *Strigilla* are present; however, it must be admitted that information regarding species in the East Indies is, at best, fragmentary. Olsson (1961) has recently treated the Eastern Pacific species and Olsson and McGinty (1958) have discussed the Western Atlantic species. In the present monograph, six species are recognized in the Western Atlantic fauna; of these, four are placed in the nominate subgenus *Strigilla*; the two remaining belong to the subgenus *Pisostrigilla*. One species of *Pisostrigilla*, one species of *Simplistrigilla*, and six species of *Strigilla* s.s. are found in the Eastern Pacific.

The geographic conditions which obtained during the early Tertiary allowed a continuous distribution of species of *Strigilla* from the Western Atlantic to the Eastern Pacific. The formation of the isthmus of Panama during the Pliocene facilitated a divergence of two faunas and today most species of *Strigilla* in the Western Atlantic have analogous species in the Eastern Pacific.

Genus *Strigilla* Turton

Strigilla Turton 1822, Conchylia Insularum Britannicarum, Dithyra, p. 117, pl. 7, fig. 15 (type species, *Tellina carnaria* Linnaeus, subsequent designation Gray 1847, p. 186).

Strigella 'Turton' Gray 1840, Syn. Cont. Brit. Mus., Ed. 42, p. 150 [error for *Strigilla* Turton].

Strigula 'Turton' Menke and Pfeiffer 1861, Malacozoologische Blätter, 7: index, p. 8, non Perry 1811 (Mollusca), [error for *Strigilla* Turton].

Strigillina 'Turton' Stoliczka 1870, Palaeontologia Indica, Cretaceous Fauna of Southern India. Pelecypoda, 3: 120, non Dunker 1862 (Mollusca), [error for *Strigilla* Turton].

Limicola 'Leach' Fischer 1887, Manuel de Conchyliologie, p. 1149, non Koch 1816 (Aves), nec 'Vieillot' Agassiz 1846 (Aves), nec 'Leach MS' Gray 1852 (Mollusca), nec Gray 1857 (Mollusca).

Strigillia 'Turton' Sowerby 1894, Jour. of Conch., 7: 376 [error for *Strigilla* Turton].

Description. Shell small or medium sized, never extending more than 2 inches in length, subcircular to subovate in shape, inequilateral with the umbos usually in front of the middle. Sculpture consisting of incised scissulations which descend across the shell from a high point along the anterior dorsal margin toward the ventral margin; these sulci may be variously flexed or angled along the posterior slope. In the left valve, the hinge dentition consists of two weak lateral teeth and of a cardinal complex including an anterior bifid tooth and a posterior laminate tooth. In the right valve, the hinge dentition consists of two strong lateral teeth with sockets above, and of a cardinal complex including a posterior bifid tooth and an anterior laminate tooth. The color of the shell is predominantly white with some suffusions of red, pink, yellow, green, or brown.

The genus *Strigilla* was originally subdivided into three groups or subgenera by Dall (1900b), who utilized morphological characters which are widely employed in the separation of taxa in the Tellinidae. These include the size and configuration of the pallial sinus as well as the relationship between that sinus and the anterior adductor muscle scar. However, in *Strigilla* the pallial sinus and its position in the valves are characters which exhibit extreme variability and, as Olsson (1961) stated, have little value in the delineation of subgenera. The only character which serves to segregate natural groups in the genus *Strigilla* is the precise nature of the scissulations which are incised obliquely over the external surface of the valves. The presence or absence of posterior flexures of the oblique sulci and the nature or number of these flexures form the most important basis for subgeneric rank. The genus may then be subdivided into at least four subgenera. The subgenus *Strigilla*, with *Tellina carinaria* Linnaeus as type, is highly developed in the Caribbean and Eastern Pacific regions but is also represented in the Australian fauna. The subgenus *Aeretica*, with *Strigilla senegalensis* Hanley as type, is represented in the fauna of the African Eastern Atlantic but is particularly developed in the Philippine region. The subgenus *Simplistrigilla*, with *Strigilla strata* Olsson as type, seems to be restricted to the Eastern Pacific. The subgenus *Pisostrigilla*, with *Tellina pisiformis* Linnaeus as type, is represented in the Caribbean fauna as well as in the Eastern Pacific.

The genus first appears in the late Oligocene of the North American Tertiary, and according to Olsson, there are no substantiated records from the Eocene.

The peculiar acentric sculpture and the suborbicular shape of the shell are diagnostic for the genus. In the Western Atlantic species, the coloration of the shell is pure white, red, or white with suffusions of red or pink. Individuals from this area never attain the size of the largest representative of the genus in the Eastern Pacific, namely *Strigilla disjuncta* Carpenter, which reaches over 40 mm. in length. Generally, the shells are solid with well developed hinge dentition, and for identification of species, details of the sculpture of the posterior slope are most important. In addition, the configuration of the pallial sinus, the disposition of the lateral and cardinal dentitions, and the formation of the ligament are diagnostic. As the acentric sulci descend across the disc, a smooth dorso-ventral band along the anterior quarter of the valve may obliterate the sulci, but this character, employed by earlier workers such as Mörch, Philippi and Carpenter, has been discarded as not being diagnostic. Indeed, the width, extent, disposition and presence or absence of this band are all variable; the full range of variation generally is present in a single population. Plate 164 illustrates the morphological traits used in the definitions and descriptions of the species treated herein.

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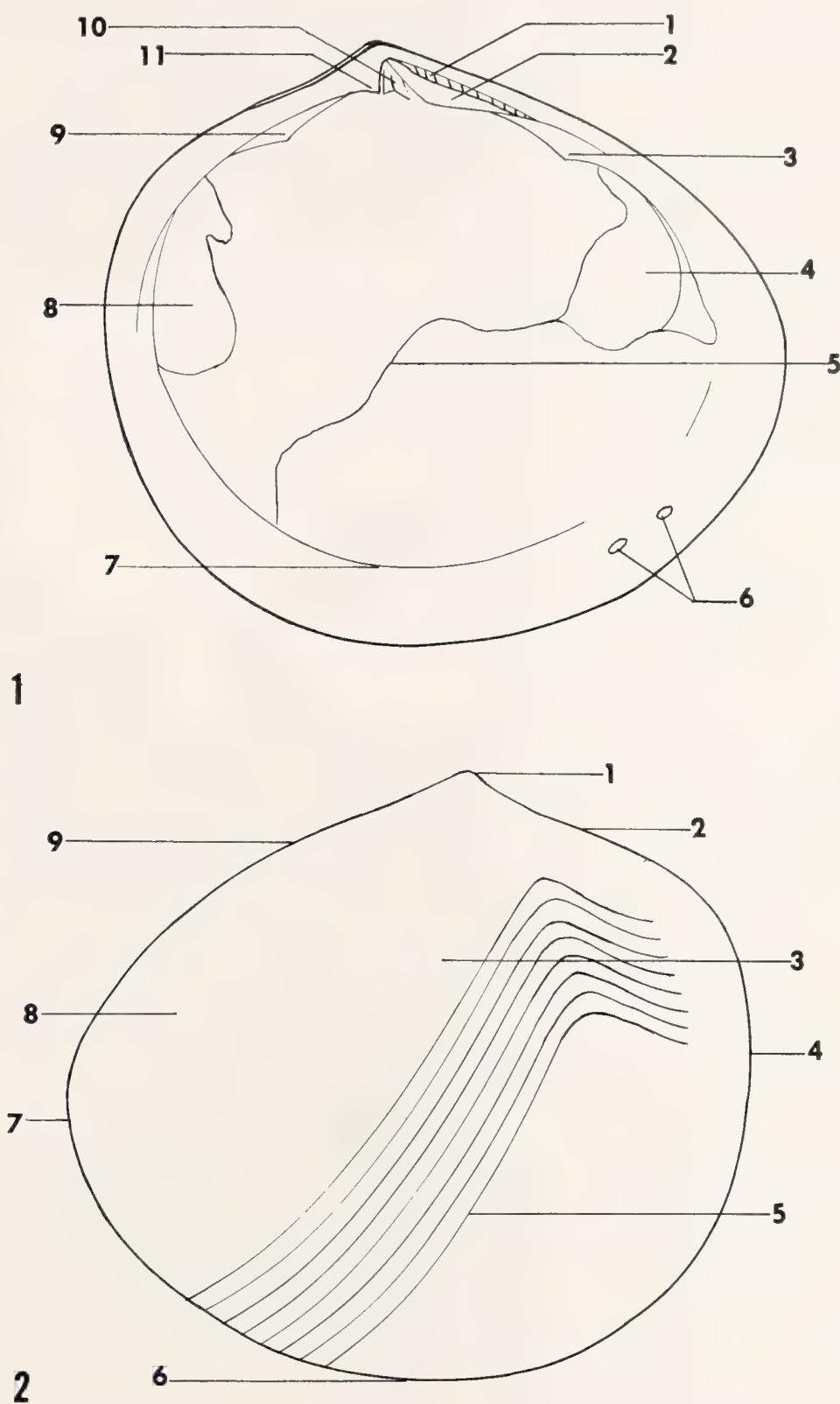
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Plate 164. Fig. 1. Diagram of the internal surface of the right valve of *Strigilla*. 1. Ligament. 2. Nympha callosity. 3. Posterior lateral tooth. 4. Posterior adductor muscle scar. 5. Pallial sinus. 6. Cruciform muscle scars. 7. Pallial line. 8. Anterior adductor muscle scar. 9. Anterior lateral tooth. 10. Bifid tooth of the cardinal complex. 11. Laminate tooth of the cardinal complex. Fig. 2. Diagram of the external surface of the right valve of *Strigilla*. 1. Umbo. 2. Anterior dorsal margin. 3. Disc. 4. Anterior margin. 5. Scissula (or acentric sulcus). 6. Ventral margin. 7. Posterior margin. 8. Posterior slope. 9. Posterior dorsal margin.

Strigilla (Strigilla) carnaria (Linnaeus)

Plate 166, figs. 3–4; Plate 167, figs. 1–2; Plate 168, fig. 1

Tellina carnaria Linnaeus 1758, *Systema Naturae*, ed. 10, p. 676 (in *Oceani brevibus*); Gmelin 1792, *Systema Naturae*, ed. 13, p. 3240 (in *Angliae sinubus et insularum Oceani americani*) [type locality, here restricted, Barbados, West Indies; syntypes, collection of Linnean Society, London].

Cardium carneosum da Costa 1779, *British Conchology*, p. 181 (change of name for *Tellina carnaria* Linnaeus).

Lucina carnaria Linnaeus. Lamarck 1818, *Animaux s. Vertèbres*, 5: 542.

Strigilla carnaria Linnaeus. Turton 1822, *Conchylia Insularum Britannicarum*, Dithyra, p. 117, pl. 7, fig. 15.

Strigilla areolata Menke 1847, *Zeitschr. f. Malak.*, 4: 188 (ad Antillas insulas) [type locality, here restricted, Barbados, West Indies; type not seen].

Strigilla rombergii Mörch 1853, *Catalogus Conchyliorum Comes di Yoldi*, 2: 15, no. 157 (Brazilia) [type locality, here restricted, Recife, Pernambuco, Brasil; holotype, Zoological Museum, Copenhagen].

Strigilla (Rombergia) rombergi [sic] Mörch. Dall 1900, *Trans. Wagner Free Inst., Sci., Philadelphia*, 3(5): 1038.

Description. Shell extending to 28 mm. (about $1\frac{1}{8}$ inches) in length and to 26 mm. (about 1 inch) in height, transversely subovate, inequilateral, equivalve, subsolid, somewhat inflated, the right valve more convex, and usually without a posterior flexure. Umbos in front of the middle, elevated above the hinge line, rather inflated, rounded and blunt. Anterior margin very broadly rounded; ventral margin convex, smoothly rounded and rising behind; anterior dorsal margin short, concave just in front of the umbos and then rounded; posterior dorsal margin more or less straight, short and steeply inclined; posterior margin poorly defined, obliquely inclined, and nearly straight. Sculpture consisting of rather evenly spaced scissulations which descend across the shell from a high point along the anterior slope toward the ventral margin. This scissulate pattern of sculpture is flexed in the posterior third of the shell where it turns sharply upward, forms an acute angle pointing ventrally and extends upward to the posterior dorsal margin. Another flexure occurs on the anterior slope where the sulci are bowed upward. Ligament brown and slightly protuberant; narrow and slightly depressed esutcheon mostly on the left valve; deeply sunken, broad and short lunule evident in the right valve. Calcareous portion of the ligament moderately developed and subtended by slightly raised nymphal callosities. Hinge line moderately well developed. In the left valve, the cardinal complex consists of an anterior small narrowly elongate bifid tooth with sharp subequal lobes and of a posterior very long and thin laminate tooth closely adpressed to the calcareous element of the ligament and coextensive with the hinge plate; anterior lateral tooth subproximal to the cardinal complex and stronger than the distal posterior lateral tooth. In the right valve, the cardinal complex consists of a posterior thickened, strongly skewed bifid tooth, whose posterior lobe is the larger and of an anterior subdeltoid laminate tooth closely adpressed to the base of the lunule. Anterior lateral tooth stronger and closer to the cardinal complex than the posterior lateral tooth; both with sockets above. The lateral dentition is stronger in the right valve. No true internal ribs present, but some radial vermiculations occur on the internal posterior surface. Adductor muscle scars generally well impressed. Anterior adductor elongate and narrow; posterior adductor rounded. Pallial sinus more or less equal in opposite valves, rising but slightly posteriorly, arcuately descending and uniting with the pallial line. The pallial sinus is well separated from the anterior adductor scar. Cruciform muscle scar round, close to the ventral boundary and the terminus of the pallial line is mid-

way between the anterior and posterior cruciform scars. Shell dull to feebly shining and predominantly white, suffused with pink, sometimes disposed in bands. Internally the surface is dull to shining but not highly polished, white, with central concentrations of pink, or all pink.

length	height	width	
26 mm.	24 mm.	—	Syntype of <i>carnaria</i> Linnaeus
21	19	9 mm.	“ “ “ “
19	17	9	“ “ “ “
19	17	8	“ “ “ “
18	16	8	“ “ “ “
15	14	8	Holotype of <i>rombergii</i> Morch
28	26	—	Charlestown, Nevis, Lesser Antilles
24	21	10	St. Martin's Island, Lesser Antilles
18	16	8	Eight Mile Rock, Grand Bahama Island
15	14	7	St. Thomas, Virgin Islands

Remarks. The specimens of *Tellina carnaria* Linnaeus are in the Linnean Collection in London; they consist of four complete specimens plus one large left valve. In the tenth and twelfth editions of the *Systema*, Linnaeus gave two references to plates, one in Lister (1678) and the other in Gualtieri (1742): both of these figures are unrecognizable but represent unlike species. Gmelin in the thirteenth edition of the *Systema* included more references to plates, and one of these (Lister, 1770, pl. 339, fig. 176) is here selected as the type figure; the localities given by Lister include the Barbados and Jamaica, and the type locality is herein restricted to the Barbados.

The present confusion in the taxonomy of this group in the Western Atlantic is due to the misinterpretation of the species '*carnaria*' and '*rombergii*' by Dall. In his papers (1900 a & b), Dall confused *S. carnaria* (Linnaeus) with a hitherto undescribed species (see *Remarks* under *Strigilla pseudocarnaria*).

This species of the subgenus *Strigilla* is unique and easily identified by its pallial sinus which is widely separated from the anterior adductor scar. The distance is usually from 2 to 5 mm. in adults. The shape of the sinus and the nature of its descent to the pallial line are somewhat diagnostic. The sinus is generally rounded dorsally and arcuate anteriorly with an irregular, more or less short straight drop to the pallial line. Young specimens of *carnaria* have somewhat different proportions than adults. The shells are shorter and the ventral margin is less convex.

From *Strigilla pseudocarnaria*, with which *S. carnaria* is most easily confounded, it may be distinguished by the pallial sinus which is removed from the anterior adductor muscle scar and by its somewhat more closely spaced scissulations. From *Strigilla gabbi*, *carnaria* may be distinguished by its wide nymphal callosity and more external ligament.

Specimens in the southernmost portion of the range, notably southern Brasil and Uruguay, tend to possess thinner shells with weaker hinge lines. The pallial sinus approaches the anterior adductor muscle scar and very rarely a fusion of the sinus and muscle scar actually occurs in some values. The color tends to become paler, with a preponderance of pale red individuals, while northern populations possess larger and heavier shelled ones.

Strigilla carnaria seems to have no counterpart in the Eastern Pacific fauna and it does not seem to be represented in the fossil record.

Range. From Florida and the Bahamas, this species extends south through the Greater and Lesser Antilles, along the coast of South America to a southernmost point at Mar del Plata, Argentina. The species does not occur in the outer Bahama Islands and is absent from the Caribbean coasts of Central and South America where it is replaced by *S. pseudocarnaria* (q.v.). Various other localities have been reported for this species, but they seem to be unfounded. Two lots in MCZ, one from Charleston, South

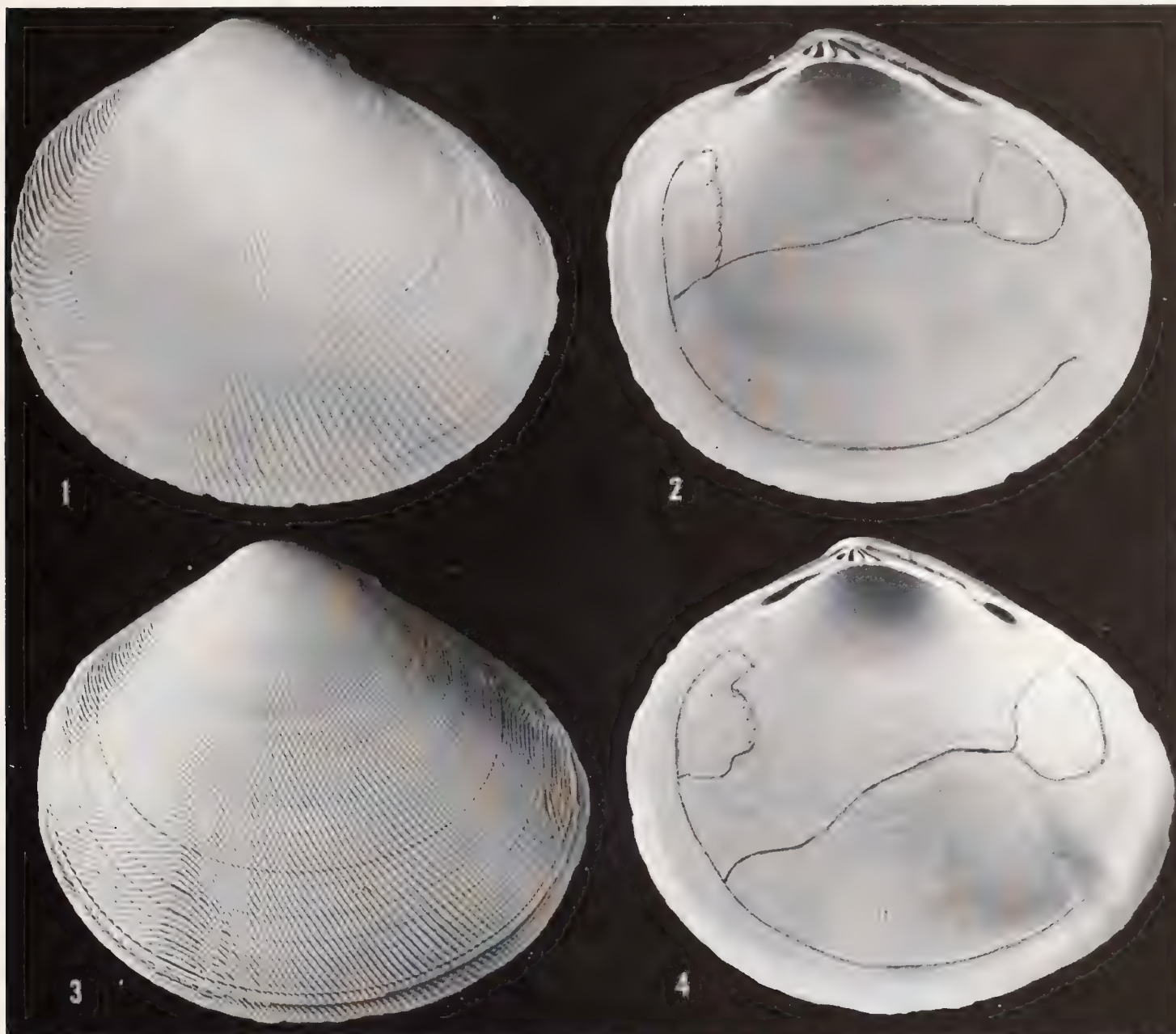


Plate 166. Fig. 1. *Strigilla pseudocarnaria* n.sp., Holotype, MCZ 212736, Bahia de Añasco, Puerto Rico (left valve external; about 4x). Fig. 2. *Strigilla pseudocarnaria* n.sp., Holotype, MCZ 212736, Bahia de Añasco, Puerto Rico (right valve internal; about 4x). Fig. 3. *Strigilla carnaria* (Linnaeus), MCZ 176519, Barbados, West Indies (left valve external; about 3.5x). Fig. 4. *Strigilla carnaria* (Linnaeus), MCZ 176519, Barbados, West Indies (right valve internal; about 3.5x).

Carolina and the other from Colón, Panama are not included in the range for there are sound reasons to doubt the authenticity of the specimens. In the case of the former, neither the check list of the mollusk fauna of South Carolina (Mazýck, 1913) nor the monograph of the Tellinidae of that state (Ravenel, 1885) mentions the occurrence of this species. In the case of the latter, Olsson and McGinty (1958) have recently treated the marine mollusks of Panama, but have not listed the occurrence of this species there.

Specimens of *S. carnaria* which were supposedly taken alive in the Straits of Bonifacio, off Corsica, and which are preserved in the British Museum (Natural History) and another lot in the same museum taken at Land's End, Cornwall, are presumed to be adventitious.

Specimens examined. FLORIDA: Miami (ANSP; USNM); Key West (MCZ); Bonita Springs (D. & N. Schmidt); Sanibel Id. (MCZ). BAHAMA ISLANDS: West End, Eight Mile Rock, and Freetown, Grand Bahama Id. (all MCZ); North Bimini Id., in 20 fathoms (USNM); Alicetown, North Bimini; Nixon's Harbour, South Bimini (both MCZ); Andros (ANSP). CUBA: Monrillo Beach, Bahia Honda, Pinar del Rio (MCZ); Cardenas Bay (USNM); Veradero Park, Cardenas (ANSP); Caibarien, and off Cayo Frigosa, Las Villas; Punta de los Colorados, Cienfuegos Bay; Rancho Aluna; mouth of Arimao River (all MCZ); Cochinos Bay (USNM); Santiago (ANSP); Fish Point, Guantanamo Bay (MCZ). JAMAICA: Montego (USNM); Dunn's River Falls, St. Anns (MCZ); St. Anns Bay; Port Maria; Harboreale near Annotta Bay; Robins Bay; Buff Bay; Port Antonio; Manchioneal (all USNM). HISPANIOLA: HAITI: Cape Haitien (MCZ); Anse de la Plateforme (USNM); Anse de Leogane (ANSP); Coteaux; Port Salut (both USNM). SANTO DOMINGO: Las Granjas, Monte Cristi; Puerto Plata; Puerto Sosua; Santa Barbara de Samana; Punta Cabereta, Cabo Macoris (all MCZ). PUERTO RICO: San Juan (MCZ); Isla Verde, San Juan (USNM); Arroyo (ANSP). VIRGIN ISLANDS: Bogarts Bay, Tortola (MCZ); St. Thomas (ANSP; USNM; BMNH; MCZ); Port Morant, St. Thomas; St. Croix (both USNM). LESSER ANTILLES: Lowlands, and Phillipsburg, St. Martin Id. (both ANSP); St. Kitts (ANSP; BMNH); Charlestown, Nevis; Guadeloupe (both MCZ); St. Lucia (ANSP); Port Castries, St. Lucia (USNM); St. Vincent (ANSP); Barbados (ANSP; USNM; MCZ); Bathsheba, Barbados (USNM); Fontenary Beach and Grande Anse, Grenada (both MCZ); Tobago (ANSP); Trinidad (MCZ). BRASIL: Recife, Pernambuco; Manguinhos, Ilha de Itaparica, Bahia; Barra Secca, Mucuri, Bahia; Vitoria, Espirito Santo; Rio de Janeiro; São Paulo; Praia Grande, Itanhaem, São Paulo; Ilha do Cardoso, Cananéia, São Paulo (all MCZ). URUGUAY: La Paloma Rocha (ANSP). ARGENTINA: Mar del Plata (USNM).

***Strigilla (Strigilla) pseudocarnaria*, new species**

Plate 166, figs. 1–2

Strigilla carnaria 'Linnaeus' H. & A. Adams 1856, *Genera Recent Mollusca*, **2**: 399, pl. 104, figs. 1 & 1a, non Linnaeus 1758.

Tellina rombergi [sic] 'Mörch' Römer 1872, *Conchilien-Cabinet* (2), **10**(4): 187, pl. 36, figs. 13–16, non Mörch 1853.

Strigilla (Strigilla) carnaria 'Linnaeus' Dall 1900. *Proc. U.S. Nat. Mus.*, **23**: 297; 1900. *Trans. Wagner Free Inst. Sci.*, Philadelphia, **3**(5): 1038.

Types. The holotype of *Strigilla pseudocarnaria* is in the Museum of Comparative Zoology 212736; the type locality is Bahia de Añasco, Puerto Rico.

Description. Shell extending to 22.5 mm. (about 7/8 inch) in length and to 19.5 mm. (about 4/5 inch) in height, transversely subovate, inequilateral, equivalve, subsolid, moderately inflated with the right valve slightly more convex and without a posterior flexure. Umbos in front of the middle, slightly elevated, somewhat inflated and rather

blunt. Anterior margin very broadly rounded and oblique to the dorso-ventral axis; ventral margin smoothly and gently rounded, rising posteriorly; anterior dorsal margin short, nearly straight and gently sloped; posterior dorsal margin long but slightly convex and rather steeply inclined; posterior margin poorly defined, irregular and generally convex. Sculpture consisting of rather evenly spaced, incised scissulations which descend across the shell from a high point along the anterior dorsal margin toward the ventral margin. This scissulate pattern of sculpture is flexed at the posterior third of the valve where it turns sharply, forms an acute angle which points ventrally and continues upward to the posterior dorsal margin. Another flexure occurs on the anterior slope where the sulci are bowed upward or partly replaced by a smooth tract. In the right valve, a weak posterior ridge extends from the umbonal area and forms an ill-defined flattened posterior dorsal slope. Weak, shallow but rather broad radial sulci occur on the posterior slope of the right valve ventral to the posterior ridge and on the anterior slope of both valves; a weak indentation occurs on the anterior margin at the terminus of the weak sulcus. Ligament dark brown in color, somewhat protuberant; escutcheon mostly on the left valve, shallow and short; lunule profound, long, well developed, larger in the left valve. Calcareous element of the ligament moderately developed, subtended by a weak, slightly raised nymphal callosity in the left valve. Hinge line rather well developed. In the left valve, the cardinal complex consists of an anterior elongate, somewhat thickened bifid tooth with subequal lobes and of a posterior thin, extremely elongate laminate tooth closely adpressed to the calcareous element of the ligament; anterior lateral tooth subproximal and stronger than the distal posterior lateral one. In the right valve, the cardinal complex consists of a posterior, thickened strongly skewed bifid tooth with a large posterior lobe and of an anterior subdeltoid, protuberant laminate tooth closely adpressed to the base of the lunule. Anterior lateral tooth subproximal, strong, and somewhat laminate; posterior lateral tooth distal, strong, and laminate; both laterals with sockets above. The lateral dentition is much stronger in the right valve. No true ribs present, but weak internal vermiculations coincident posteriorly with the cruci-

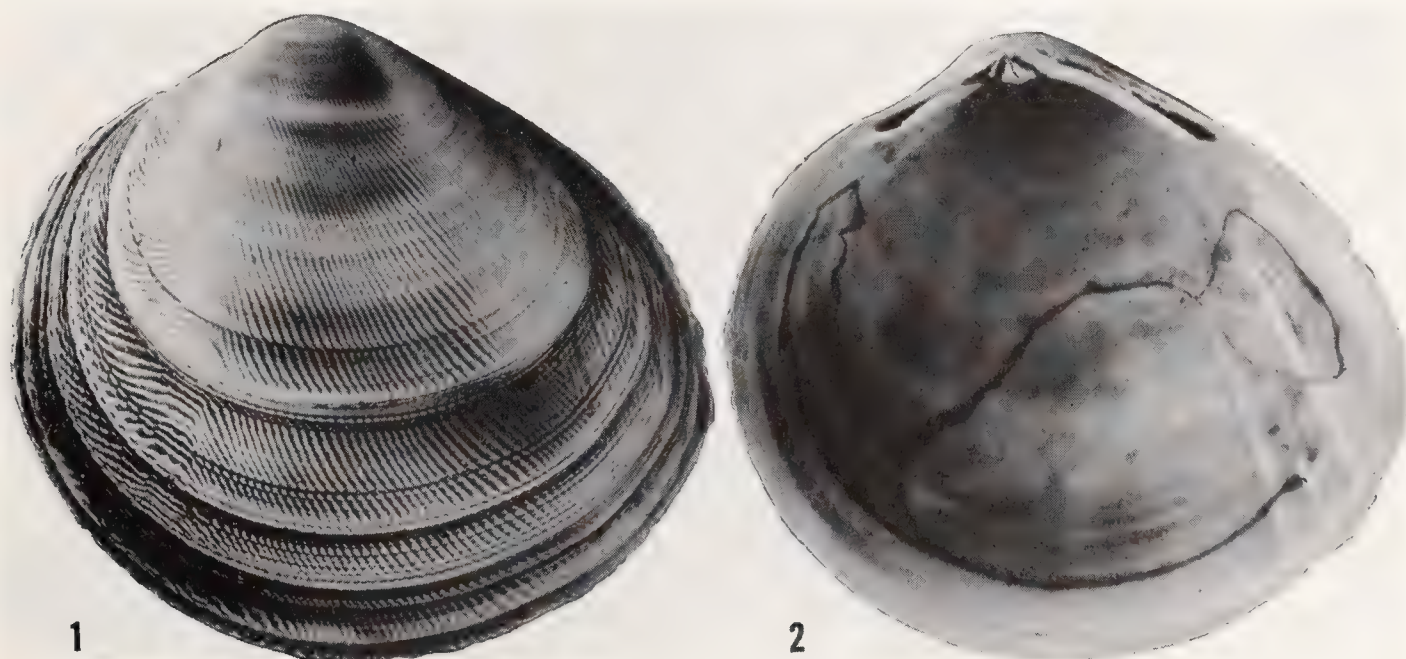


Plate 167. *Strigilla rombergii* Mörch [= *Strigilla carnaria* Linnaeus], Holotype, Zoological Museum, Copenhagen (left valve external; about 5x). Fig. 2. *Strigilla rombergii* Mörch [= *Strigilla carnaria* Linnaeus], Holotype, Zoological Museum, Copenhagen (right valve internal; about 5x).

form muscle scars evident. Adductor muscle scars well impressed. Anterior adductor scar broad and elongate; posterior adductor scar transversely quadrate. Umbonal cavity profound. Pallial sinus more or less equal in opposite valves, hardly rising behind, slightly arcuate above and extending to and uniting with the base of the anterior adductor; confluence with the pallial line entire. Rarely the pallial sinus does not unite with the anterior adductor and a narrow space separates them. Cruciform muscle scars round, though the anterior cruciform scar of the left valve is rectangular; the terminus of the pallial line rises posteriorly and is located midway between the cruciform scars. Externally the shell is dull to shining, predominantly white with concentrations of pink or crimson disposed at times concentrically. Internally the shell is shining but usually not highly polished.

length	height	width	
17.0 mm.	15.5 mm.	7.0 mm.	Holotype of <i>pseudocarnaria</i> n. sp.
22.5	19.5	—	Punta Algarrobo, Puerto Rico
20.0	18.5	9.0	Monte Cristi, Santo Domingo
19.0	17.0	8.0	Bahia de Añasco, Puerto Rico
15.0	13.5	6.5	“ “ “ “ “
10.3	9.1	4.4	Cartagena, Colombia

Remarks. *Strigilla pseudocarnaria* has long been recognized as a relatively common West Indian species, but it has been confused under a number of different names and has never been properly described. Dall (1900a) recognized the presence of two closely related species and referred to one as ‘carnaria’ Linnaeus and the other as ‘rombergii’ Mörch. A study of the type specimens has proved that *carnaria* Linnaeus and *rombergii* Mörch are synonymous and that *carnaria* ‘Linnaeus’ Dall is an undescribed species.

Fossil records for *Strigilla pseudocarnaria* are relatively rare. It has been found in the Pleistocene at Fort Morgan, Alabama in wells at depths of 100–122 and 169–175 feet.

In the Western Atlantic, *Strigilla pseudocarnaria* may be most frequently confused with *S. gabbi* and *S. carnaria*. From *gabbi*, *pseudocarnaria* may be distinguished by its greater inflation, its prominent external ligament, its more distally removed right anterior lateral tooth, and its broader sculpture on the posterior slope. From *carnaria*, *pseudocarnaria* is separated by its pallial sinus which unites with the anterior adductor muscle scar in both valves and by its less coarse sculpture. Younger specimens of *S. pseudocarnaria* might be confused with *S. producta*, but the former has its right bifid cardinal tooth strongly skewed posteriorly whereas the latter possesses a perpendicular bifid cardinal tooth in the right valve. In addition, the posterior portion of *producta* is markedly produced or extended.

An isolated population or group of populations of *pseudocarnaria* have been recognized by Olsson in the Eastern Pacific, in an area from Panama to northern Peru. The distribution of this species, if Olsson’s observations are correct, is discontinuous. In the Eastern Pacific, *pseudocarnaria* is also very closely allied to *Strigilla chroma* Salisbury [= *fucata* Gould], but minor differences in the sculpture on the posterior slope as well as differences in shape and size of opposite valves do occur and are species-specific. According to Olsson, *chroma* is smaller and less equivalve. Furthermore, *chroma* has, on its posterior dorsal surface, a small escutcheon-like area which is separated from the remainder of the surface of the shell by a ridge and which is sculptured by irregular and somewhat zig-zagged lines.

Range. In the Western Atlantic, this species is more or less restricted to the Caribbean Sea. From Jamaica, Hispaniola, and Puerto Rico in the north, the range extends to Trinidad. It is found along the Caribbean coast of Central and South America.

Specimens examined. HONDURAS: Puerto Cortes (USNM; MCZ); Tela; Ceiba (both USNM); Utila, Bay Islands; Trujillo (both MCZ); Mosquito Coast (USNM). NICARAGUA: Waunta Haulover (ANSP; USNM; MCZ); America (USNM); San Juan del Sur (MCZ). COSTA RICA: Tortaguero Beach (MCZ); Puerto Limón (USNM). PANAMA: Chagres (MCZ); Colón (USNM). JAMAICA: Black River; Great Pedro Bay; Kingston (all USNM). HISPANIOLA: HAITI: Jeremie; Baie Anglaise; Les Cayes; Ile a Vache; St. Louis; Aquin (all USNM); Jacmal (ANSP); Anse de Cleve (USNM). SANTO DOMINGO: Manzanillo Bay, near mouth of Yaque River (MCZ); Monte Cristi (ANSP; MCZ); Puerto Plata (MCZ); Punta Cabereta; Cabo Macoris (both MCZ). PUERTO RICO: Punta Algarrobo (ANSP; MCZ); Isla Desecheo (USNM); Mayagüez (ANSP; MCZ); Bahia de Añasco (MCZ); Ponce; Arroyo (both ANSP); Punta Lima (ANSP; MCZ). VIRGIN ISLANDS: St. Thomas (ANSP). LESSER ANTILLES: Charlestown, Nevis (MCZ); Marigot, Dominica; Port Castries, St. Lucia (both USNM); Tobago (ANSP); Manzanilla Beach, Ortoire River, and Mayaro Beach, Trinidad (all MCZ). COLOMBIA: mouth of Atrato River; Covenas, Bolivar (both USNM); Cartagena (USNM; MCZ). VENEZUELA: Guanta (ANSP).

***Strigilla (Strigilla) producta* Tryon**

Plate 171, fig. 2

Strigilla producta Tryon 1870, American Jour. Conch., 6: 24, pl. 1, fig. 4 (Jamaica) [syntypes, ANSP, no. 53377].

Description. Shell extending to 10 mm. (about 2/5 inch) in length and to 9.2 mm. (about 3/8 inch) in height, subtrigonal, produced behind, inequilateral, equivalve, sub-solid, moderately inflated with both valves of more or less equal convexity and with little or no flexure to the right posteriorly. Umbos in front of the middle, little elevated above the hinge line, slightly inflated and blunt. Anterior margin very broadly rounded and sometimes almost straight; ventral margin broadly arcuate and rising gently behind; anterior dorsal margin short and rather straight; posterior dorsal margin long, straight and rather steeply inclined; posterior margin poorly defined, short, more or less straight, parallel to the dorso-ventral axis and forming a characteristic blunt truncation. Sculpture consisting of feeble concentric lines of growth transected by strong, regularly spaced sulci or scissulations which descend across the surface of the shell from a high point on the anterior dorsal slope toward the ventral margin; there are 7–9 scissulations per millimeter on the disc. The scissulate sculpture on the posterior quarter of the valve turns and rises sharply, forming an acute angle pointing ventrally, and then it extends upward to the posterior dorsal margin. Ligament light yellowish brown, short, not protuberant, and somewhat sunken in a poorly defined broad escutcheon; lunule broad, short and shallow. Calcareous portion of the ligament moderately developed; no true nymphaal callosities present. Hinge line rather well developed with strong lateral dentition. In the left valve, the cardinal complex consists of an anterior, narrow, slightly sulcated bifid tooth with more or less equal lobes and a posterior thin laminate tooth closely

adpressed to the calcareous portion of the ligament and often broken or lost; anterior and posterior lateral teeth subequal in strength, flange-like, thin, and laminate; the anterior lateral tooth is closer to the cardinal complex than the posterior one. In the right valve, the cardinal complex consists of a posterior elongate, thickened and protuberant bifid tooth with more or less equal lobes which are not skewed posteriorly and of an anterior thickened, laminate tooth which is fused to the base of the lunule; anterior and posterior lateral teeth subequal in strength, slightly thickened, elongate and with sockets above; the anterior one is much nearer the cardinal complex than the posterior one. The lateral dentition of the left valve is weaker. Two obscure radial posterior ribs evident. Adductor muscle scars poorly impressed. Anterior adductor scar elongate and narrow; posterior adductor subtrigonal. Pallial sinus more or less equal in opposite valves, rising slightly from the base of the posterior adductor scar, broadly convex above, descending arcuately to unite with the pallial line near to the base of the anterior adductor scar. The pallial sinus may touch the base of the anterior adductor scar or be slightly removed from it. Cruciform muscle scars poorly impressed and located on the ventral terminus of the weak posterior radial ribs. Shell white with red, crimson, or rose concentrated in the umbonal region. External and internal surfaces shining but not polished.

length	height	width	
10.0	9.2 mm.	—	Mayagüez, Puerto Rico
9.5	7.9	4.6 mm.	Bahia de Añasco, Puerto Rico
7.6	6.1	3.7	Jamaica
6.4	5.3	—	Monte Cristi, Santo Domingo

Remarks. This species is characterized by its subtrigonal shape, its produced posterior end and its white color with red, rose, or pink concentrated centrally in the umbonal area. It is most often confused with *S. pisiformis* because of the similar color pattern. However, it may be immediately separated, for in *pisiformis* the scissulate pattern of sculpture is flexed in a single zig zag posteriorly whereas in *producta* there is only a single flexure without any zig zags.

In the Western Atlantic, *S. producta* is most closely related to *S. pseudocarnaria*. It differs from *pseudocarnaria* in its smaller size, its subtrigonal shape, and its extremely long posterior dorsal margin. An important distinguishing character of *producta* is the short, protuberant, and perpendicular bifid cardinal tooth in the right valve. In *pseudocarnaria*, the right bifid cardinal tooth is strongly skewed posteriorly and somewhat thickened. The closest Eastern Pacific relative of *producta* is *S. dichotoma* Philippi. From this species, *S. producta* may be distinguished by its much more trigonal shape, its elongate posterior dorsal slope, and its more closely spaced sulci.

Range. This species is rather rare, but it occurs in the Caribbean from Panama in the west and from Jamaica in the north through the Antilles and south to Barra Secca, Brasil.

Specimens examined. PANAMA: Colón (MCZ). JAMAICA: (ANSP). HISPANIOLA: Monte Cristi and Santa Barbara de Samana, Santo Domingo (both MCZ). PUERTO RICO: Mayagüez, in 12 feet; Bahia de Añasco; Humacao (all MCZ). LESSER ANTILLES: Gulf of Paria, Trinidad (MCZ). BRASIL: Barra Secca (MCZ).

Strigilla (Strigilla) gabbi Olsson and McGinty

Plate 168, fig. 2

Strigilla gabbi Olsson and McGinty 1958, Bull. American Paleo., **39**(177): 50, pl. 5, figs. 3-3a (Colón, Panama) (holotype, ANSP, no. 218881).

Description. Shell extending to 35 mm. (about 1 2/5 inches) in length and to 30.5 mm. (about 1 1/5 inches) in height, subcircular, inequilateral, equivalve, solid, somewhat compressed with the right valve of a slightly greater convexity and without a posterior flexure. Umbos markedly in front of the middle, little inflated or elevated, blunt and

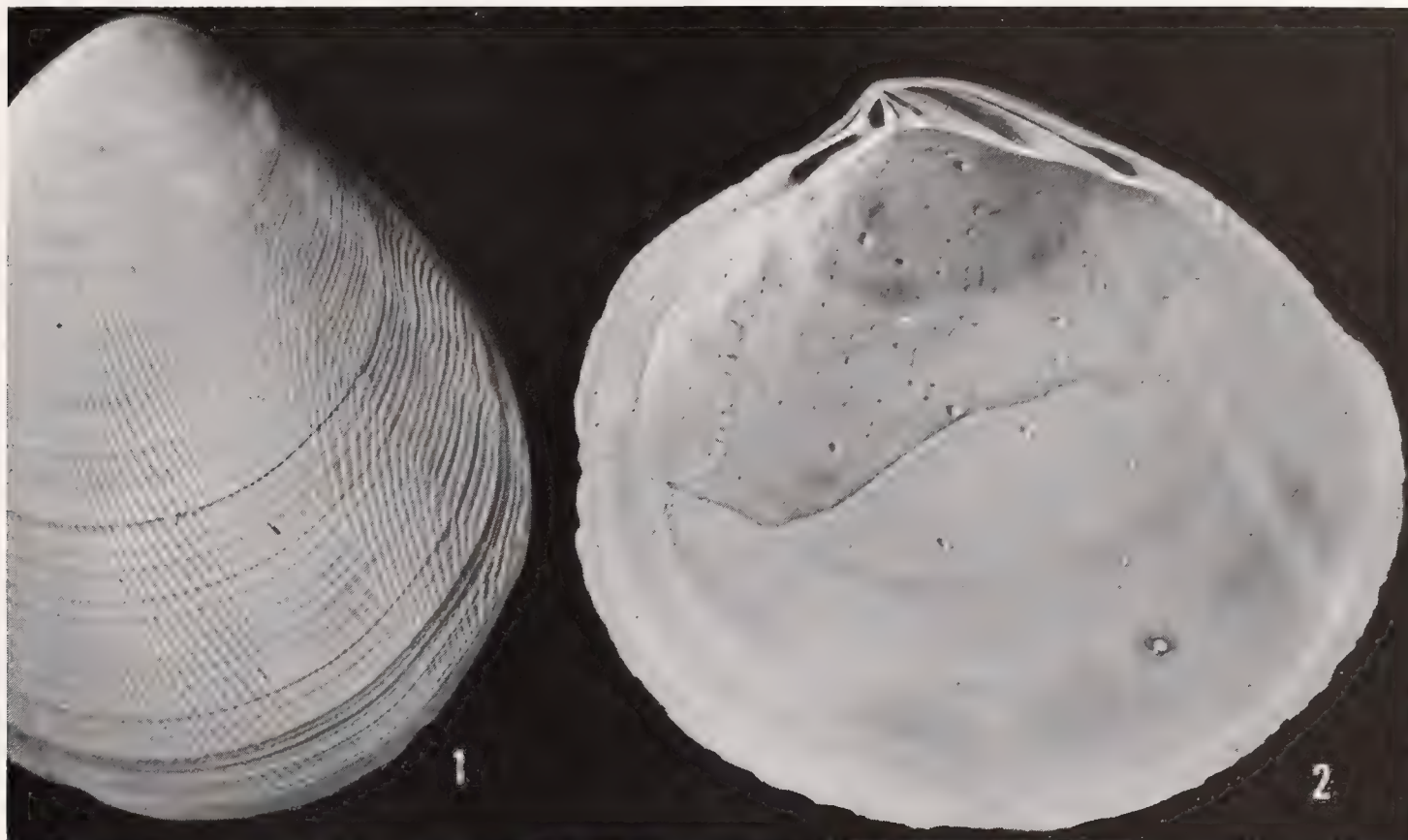


Plate 168. Fig. 1. *Strigilla carnaria* (Linnaeus), MCZ 176519, Barbados, West Indies (posterior dorsal slope of the left valve; about 3x). Fig. 2. *Strigilla gabbi* Olsson and McGinty, Paratype, ANSP 53379, Costa Rica, (right valve internal; about 3.2x).

conspicuously prosogyrous. Anterior margin very broadly rounded and somewhat parallel to the dorso-ventral axis; ventral margin broadly arcuate and convex; anterior dorsal margin short; posterior dorsal margin long and slightly convex; posterior margin poorly defined, short, slightly convex. Sculpture consisting of irregular concentric lines of growth transected by regularly spaced scissulations which descend at angles of 60-90 degrees across the surface of the shell from a high point along the anterior dorsal margin toward the ventral margin. This scissulate pattern of sculpture is flexed at the posterior third of the valve where it turns sharply, forms an acute angle which points ventrally, and extends upward to the posterior ventral margin; the sulci are closely set, crowded, and less well defined on the posterior third of the valve. Another flexure occurs on the anterior slope where the sulci are bowed upward or partly replaced by a smooth tract. In the right valve, a high and dorsal posterior ridge extends from the umbonal area and forms a flattened, narrow posterior dorsal slope; a similar but smaller and less well defined ridge and slope occur in the left valve. Ligament black, deeply sunken or inset;

narrow escutcheon in the left valve; lunule small, narrow, deeply sunken, and larger in the left valve. Calcareous portion of the ligament well developed, deeply inset, and supported on flattened nymphs; no raised nymphal callosities present. Hinge line well developed. In the left valve, the cardinal complex consists of an anterior elongate, narrow, and weakly sulcate bifid tooth and of a posterior thin, elongate laminate tooth which is closely adpressed to the calcareous portion of the ligament and may be lost or destroyed in adults; anterior lateral tooth subproximal to the cardinal complex and stronger than the distal posterior one. In the right valve, the cardinal complex consists of a posterior thickened and skewed bifid tooth whose posterior lobe is the larger and of an anterior strong but small laminate cardinal tooth; anterior lateral tooth very close to the cardinal complex, strong, and with a socket above; posterior lateral tooth distal, pointed, small, much weaker than the anterior lateral tooth and with a socket above. The lateral dentition is weaker in the left valve. Two radial posterior and internal ribs evident and with their distal ends coincident with the cruciform muscle scars. Adductor muscle scars moderately well impressed. Anterior adductor scar somewhat narrow and elongate; posterior adductor scar transversely subquadrate. Pallial sinus more or less equal in both valves, rising slightly behind, convex above, and falling to the pallial line in a sigmoid fashion. The pallial sinus extends toward the anterior adductor and is usually removed from it though rarely it touches and unites with the base of this scar. Cruciform muscle scars well impressed, closely set, and at the distal ends of the internal radial ribs; the pallial line rises sharply posteriorly and ends close to the anterior cruciform scar. Externally, the shell is dull or slightly shining; predominantly white suffused with pink, often disposed in a concentric pattern. Internally, the surface may be dull or slightly shining, but never highly polished. The shell is pink, red, or crimson with the two posterior rays.

length	height	width	
33.3 mm.	30.5 mm.	12.8 mm.	Holotype of <i>gabbi</i> Olsson and McGinty
25.5	24.0	9.5	Key West, Florida
22.5	20.7	9.0	Courland Bay, Tobago
21.5	19.5	8.5	Bimini, Bahama Islands
13.5	11.5	5.5	Courland Bay, Tobago
12.5	11.0	—	Recife, Brasil

Remarks. This species though recently described has previously been confused with *S. disjuncta* Carpenter (= *sincera* Hanley) of the Eastern Pacific, but has most often remained unnoticed in lots of *S. carnaria* and *S. pseudocarnaria*. According to Olsson and McGinty (1958), *S. gabbi* differs from *S. disjuncta* in that the former is more circular in form, pink in color, and with a more angular posterior dorsal area. In addition, the umbos of *gabbi* appear to be more strongly prosogyrous and the compression of the valves is greater than in *disjuncta*. Nevertheless, the two are closely allied species derived from some common ancestor. Young specimens of *gabbi* are distinctly more rounded and the umbos are strongly prosogyrous, pointed, glabrous and pink.

Strigilla gabbi, the largest species of the genus in the Western Atlantic, is similar in some respects to *carnaria* and *pseudocarnaria*. From *carnaria*, it may be immediately distinguished by the pallial sinus which extends directly to the base of the anterior adductor and either unites with it or is separated by a very narrow space. In addition, *gabbi* is characterized by its posterior slope on which the sulci are noticeably more

crowded, by its strong hinge line which lacks an escutcheon and possesses a sunken, almost internal ligament, and by its markedly prosogyrous umbos. On the dorsal posterior slope of the right valve of *gabbi*, a radial umbonal ridge occurs and delineates a dorsal flattened area; neither *carnaria* nor *pseudocarnaria* possess such a structure.

Along the Texas coast, *gabbi* has been found in Pleistocene deposits. A little known fossil, *S. caimitica* Maury from the lower Miocene of Santo Domingo resembles *gabbi* in general shape.

Range. This species ranges from Key West and the Bimini Islands south through the Caribbean and the Antilles to a southernmost point at Recife, Brasil.

Specimens examined. FLORIDA: Key West (MCZ). BAHAMA ISLANDS: Bimini (MCZ). TEXAS: Rockport (Pleistocene fossil, MCZ). NICARAGUA: Waunta Haulover (USNM). COSTA RICA: Puerto Limón (USNM). PANAMA: Bocas del Toro (*teste* Olsson); Rio Salute (USNM); Colón (ANSP). LESSER ANTILLES: Castries, St. Lucia (USNM); Bucco Bay and Courland Bay, Tobago; Trinidad (all MCZ). COLOMBIA: Puerto Colombia (*teste* Olsson); Atrato; Cartagena; Dibulla (Magdalena) (all USNM). DUTCH GUIANA: Nickerie (Leiden Mus.); Coronie (USNM). BRASIL: Recife (MCZ).

Subgenus *Pisostrigilla* Olsson

Pisostrigilla Olsson 1961, Panamic-Pacific Pelecypoda, Paleontological Research Inst., Ithaca, p. 390 [type species, *Tellina pisiformis* Linnaeus, original designation].

Description. Shell with the incised sculpture flexed in a zig zag fashion on the posterior slope so as to form a series of alternating acute angles which point dorsally or ventrally. Shell generally small, convex, solid, and with a coarse hinge.

Strigilla (*Pisostrigilla*) *pisiformis* Linnaeus

Plate 165, fig. 2; Plate 169, fig. 2; Plate 170, figs. 1-2

Tellina pisiformis Linnaeus 1758, Systema Naturae, ed. 10, p. 677 (ad O. Europaei ostia fluviorum) (type locality, here restricted, Santa Barbara de Samana, Santo Domingo) [type specimen, collection of Linnean Society, London].

Cardium discors Montagu 1803, Test. Brit., p. 84 (substitute name for *Tellina pisiformis* Linnaeus).

Lucina pisiformis Fleming 1828, British Animals, London, p. 442.

Lucina pulchella Adams 1845, Proc. Boston Soc. Nat. Hist., 2: 10 (Jamaica) [paratypes, BMNH].

Strigilla piciformis Linnaeus. H. & A. Adams 1856, Genera Recent Mollusca, 2: 399 (error for *pisiformis*).

Strigilla pisum Linnaeus. Simpson 1889, Proc. Davenport Acad. Nat. Sci., 5(1): 45-72 (error for *pisiformis*).

Strigilla (*Strigilla*) *pisiformis* Linnaeus. Dall 1900, Trans. Wagner Free Inst. Sci., 3(5): 1038.

Strigilla pilsbryi Olsson and McGinty 1958, Bull. American Paleo., 39(177): 50, pl. 5, figs. 2-2a (Bocas del Toro, Panama) [holotype, ANSP, no. 211915].

Description. Shell extending to 13.3 mm. (about $\frac{1}{2}$ inch) in length and to 12.8 mm. (about $\frac{1}{2}$ inch) in height, transversely subovate, somewhat produced behind, slightly inequilateral, equivalve, solid, inflated with both valves about equally convex and without a posterior flexure. Umbos in front of the middle, somewhat elevated, inflated and blunt. Anterior margin very broadly rounded, sometimes flattened, straight, and nearly parallel to the dorso-ventral axis; ventral margin smoothly rounded, convex and rising gently behind; anterior dorsal margin very short and straight; posterior dorsal margin

rather steeply inclined, straight to slightly convex and longer than the anterior dorsal margin; posterior margin poorly defined, convex and obliquely rounded. Sculpture consisting of incised, rather evenly spaced scissulations which descend across the surface of the shell from a high point on the anterior dorsal margin toward the ventral margin. This scissulate pattern of sculpture flexes in the posterior third of the valve, forms an acute angle pointing ventrally, continues upward, reverses direction once again to form an acute angle pointing dorsally and ends at the posterior dorsal margin. The second flexure occurs high on the posterior slope, and the sulci here are stronger and broader than they are on the disc. A third flexure occurs on the anterior slope, where the sulci

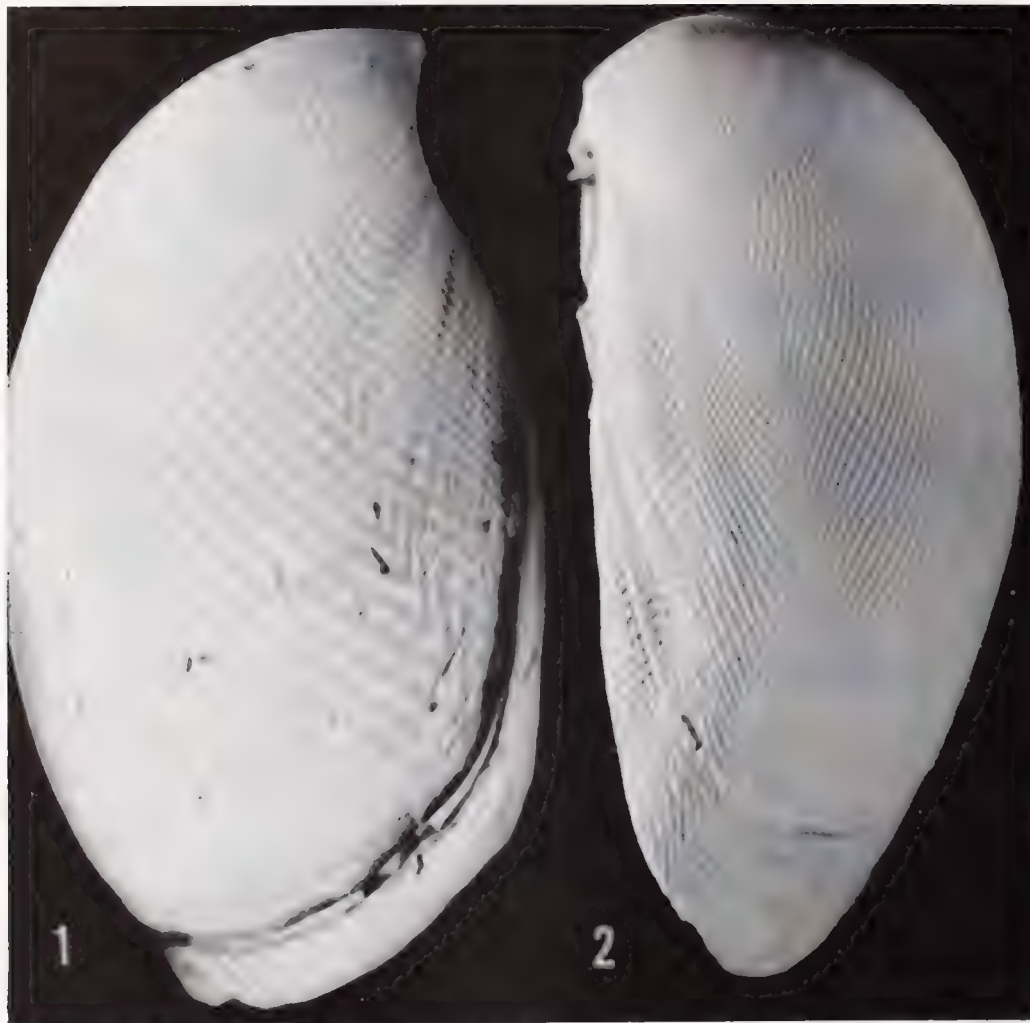


Plate 169. Fig. 1. *Strigilla mirabilis* Philippi, MCZ 195612, Pensacola, Florida (posterior dorsal slope of the left valve; about 11x). Fig. 2. *Strigilla pisiformis* (Linnaeus), ANSP 45887, Livingston, Guatemala (posterior dorsal slope of the right valve; about 10x).

are bowed upward. No well defined ridge present in either valve. Ligament light to dark brown, short, not protuberant and rather deeply set; escutcheon mostly confined to the left valve, rather deep and elongate; lunule broad, profound, and more extensive in the left valve; calcareous portion of the ligament not strongly developed and supported on flattened nymphal plates. Hinge line well developed and thickened. In the left valve, the cardinal complex consists of an anterior small, subdeltoid, poorly sulcated bifid tooth with more or less equal lobes and of a posterior elongate and thin laminate tooth closely adpressed to the calcareous element of the ligament; anterior lateral tooth smaller, thicker and nearer to the cardinal complex than the distal posterior lateral tooth. In the right valve, the cardinal complex consists of a posterior thickened and slightly skewed bifid tooth with variable lobes and of an anterior subdeltoid laminate tooth closely ad-

pressed to the base of the lunule; anterior and posterior lateral teeth thickened, strong and with the sockets above; the anterior lateral tooth is closer to the cardinal complex. The lateral dentition of the right valve is much stronger and heavier than that of the left. No true ribs are developed. Adductor muscle scars poorly impressed. Anterior adductor scar elongate; posterior adductor subquadrate. Pallial sinus more or less equal in opposite valves, rising slightly behind, convex above and falling to the pallial line some distance short of the anterior adductor; the distance that separates the pallial sinus from the anterior adductor is quite variable. The cruciform muscle scars rather poorly impressed, large and round. Externally, the shell is dull or shining, white in color suffused with red, or pink and sometimes pure white. Internally, dull or shining, and generally white suffused with pink concentrated in the umbonal region.

length	height	width	
11.0 mm.	10.5 mm.	—	Holotype of <i>pisiformis</i> Linnaeus
13.3	13.5	—	Holotype of <i>pilsbryi</i> Olsson and McGinty
13.3	12.8	—	Bahia de Añasco, Puerto Rico
10.5	10.0	—	Zapero Island, Maracaibo, Venezuela
10.4	10.0	6.5 mm.	Matanzas Bay, Cuba
7.1	6.5	4.1	Colón, Panama
6.2	5.4	3.6	Santa Barbara de Samana, Santo Domingo

Remarks. Dodge (1952) has remarked that of all the descriptions given by Linnaeus for the bivalve mollusks in his *Systema*, *pisiformis* was the most closely delineated, and that the description alone is sufficient to identify the species. Unfortunately, the type locality, general as it is, is incorrect, and the figure of Gualtieri referred to by Linnaeus is of no value. Furthermore, having copied the wrong letter from the Gualtieri plate, Linnaeus cited the incorrect figure, and, according to Dodge, the original specimens were later replaced. Nevertheless, the concept and definition for *pisiformis* have survived.

Recently, Olsson (1961) has described *panamensis*, an Eastern Pacific species which is a close relative to *pisiformis*, but the former may be distinguished by its 'pure white color and more rounded form.' *Strigilla pilsbryi*, recently described by Olsson and McGinty, proves upon examination of the type to be indistinguishable from *T. pisiformis*. In the Western Atlantic, *pisiformis* has often been confused with *producta*, which is similarly colored, but the former is markedly shorter and has a zig zag sculpture. The nearest living ally to *pisiformis* in the Western Atlantic is *mirabilis*, but these two species are unlike in shell thickness, umbonal inflation, and dental characters. From *mirabilis*, *pisiformis* may always be separated by the single zig zag flexure of the oblique sulci on the posterior slope.

In the fossil record, *Strigilla pisiformis* is well represented. Maury (1917) reported it from Cercado de Mao of the Lower Miocene of Santo Domingo, and Dall (1900b) and Woodring (1925) listed it from the Middle Miocene of the Bowden marl of Jamaica. Woodring has indicated that the Bowden specimens are smaller than those in the Recent fauna. Maury (1925) substantiated its occurrence in the Pliocene of Trinidad and later (1934) she reported it from the Pleistocene of Brasil at Thibau, Rio Grande do Norte. Dall indicated that this species is generally widespread in the Pleistocene of the Antillean region.

Range. From off the southeastern coast of Florida in the vicinity of Cape Florida and from the Bimini Islands in the Bahamas, this species extends southward through the Greater Antilles, around the shores of the Caribbean in Central and South America, through the Lesser Antilles and down the eastern coast of South America to an extreme southern record at São Francisco, Santa Catarina, Brasil.

Specimens examined. FLORIDA: off Fowey Light, in 75–90 fathoms; off Sand Key, in 61–90 fathoms; off Ajax Reef, in 80–100 fathoms (all USNM). BRITISH HONDURAS: Belize; Punta Gorda (both USNM). GUATEMALA: Livingston (ANSP). HONDURAS: Puerto Cortez (MCZ). NICARAGUA: Monkey Point (USNM). PANAMA: Rio Biarra, Chiriqui Lagoon (ANSP); Colón; Chagres (both MCZ). BAHAMA ISLANDS: off North Bimini Island, in 20 fathoms; Nassau, New Providence; Cockburntown, Watling (all USNM). CUBA: Matanzas; Gibara, Oriente (both MCZ). JAMAICA: Montego Bay; Port Maria; Port Antonio; Black River; Great Pedro Bay; Kingston (all USNM). HISPANIOLA: HAITI: Port au Prince; Anse de Clerc; Coteaux; Les Cayes; Baie Anglaise; St. Louis; Anse a Drick; Aquin; Bizoton; Saltrou (all USNM). SANTO DOMINGO: Monte Cristi (ANSP; MCZ); Puerto Plata (MCZ); Matanzas, near Encords Bay (USNM); Santa Barbara de Samana (ANSP; MCZ). PUERTO RICO: Aquadilla (USNM); Bahia de Añasco (MCZ); Mayagüez, in 12 feet (ANSP; MCZ); Isla Desecheo (USNM); Ponce (ANSP); San Juan (USNM); Humacao Playa; Boca de Congrejos (both MCZ). VIRGIN ISLANDS: St. Thomas (ANSP). LESSER ANTILLES: Guadeloupe (ANSP); Dominica; Grenada (both USNM). COLOMBIA: Covenas, Bolivar; Cartagena (both USNM). VENEZUELA: Zapero Island, Lake Maracaibo, Zulia (MCZ); 4.3 km. W of Barcelona (USNM). BRASIL: Recife, Pernambuco; Manguinhos, Ilha de Itaparica, Bahia; Barra Secca, Bahia (all MCZ); Ilha de São Sebasião, São Paulo; Ilha de São Francisco, Santa Catarina (both USNM).

Strigilla (Pisostrigilla) mirabilis Philippi

Plate 165, fig. 3; Plate 169, fig. 1; Plate 171, fig. 1

Tellina flexuosa Say 1822, Jour. Acad. Nat. Sci. Philadelphia, **2**: 303 (inhabits the southern coasts), non *flexuosa* Montagu 1803 [types lost].

Tellina mirabilis Philippi 1841, Wieg. Archiv. für Naturgeschichte, **7**: 260 (Sinus mexicanus, litus australe statuum unitorum) [types not seen].

Strigilla flexuosa Say. H. & A. Adams 1856, Genera Recent Mollusca, **2**: 399.

Strigilla carolinensis Conrad 1862, Proc. Acad. Nat. Sci. Philadelphia, p. 573 (Miocene of Peedee River, South Carolina) [types not seen].

Strigilla fluxuosa 'Say' Conrad 1862, Proc. Acad. Nat. Sci. Philadelphia, (1862), p. 573 (error for *flexuosa* Say).

Strigilla mirabilis Philippi. Olsson and McGinty 1958, Bull. American Paleo., **39**(177): 48.

Description. Shell extending to 14 mm. (about 9/16 inch) in length and to 13 mm. (about 1/2 inch) in height, transversely subovate, a little produced behind, inequilateral, equivalve, rather solid, inflated with both valves of more or less equal convexity and without a posterior flexure. Umbos located anterior to the middle, slightly elevated above the hinge line, somewhat flattened and blunt. Anterior margin very broadly rounded, sometimes more or less straight and parallel to the dorso-ventral axis; ventral margin broadly arcuate and rising only a little behind; anterior dorsal margin short,

straight to concave; posterior dorsal margin slightly convex and very long; posterior margin smoothly rounded, poorly defined, and convex. Sculpture consisting of strongly incised, more or less evenly spaced scissulations which descend across the surface of the shell from a high point on the anterior dorsal margin toward the ventral margin. The scissulate pattern of sculpture possesses a series of flexures on the posterior slope; the

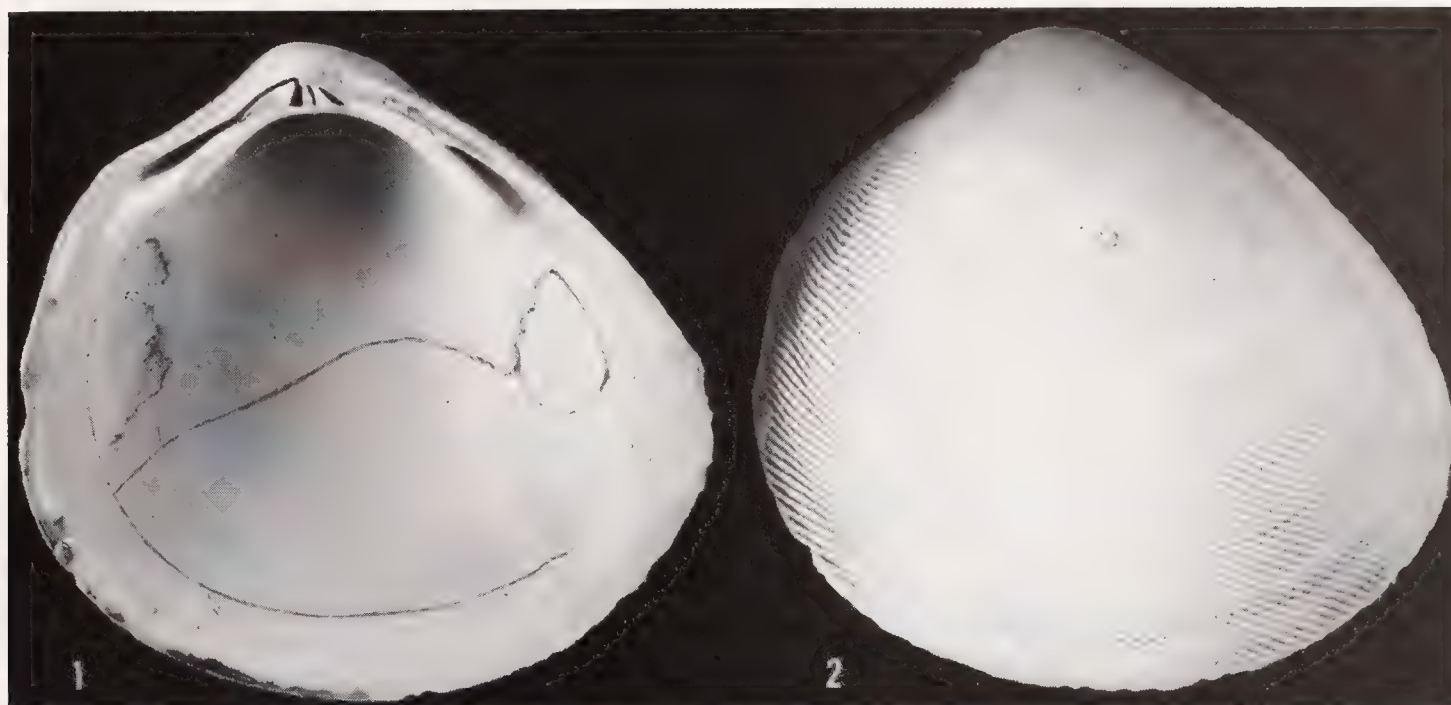


Plate 170. Fig. 1. *Strigilla pisiformis* (Linnaeus), ANSP 45887, Livingston, Guatemala (right valve internal; about 5x). Fig. 2. *Strigilla pisiformis* (Linnaeus), ANSP 45887, Livingston, Guatemala (left valve external; about 5x).

pattern appears as a sequence of zig zags where the flexures form acute angles which point dorsally or ventrally. There may be from four to six flexures on the posterior slope. Posterior ridge lacking in either valve though an irregular shallow radial sulcus sometimes occurs in the left valve. Ligament light to dark brown, rather short, and somewhat sunken; escutcheon weak, shallow, and lanceolate; lunule short, broad and rather profound. Calcareous element of the ligament poorly developed; nymphal plates flattened. Hinge line well developed and thickened. In the left valve, the cardinal complex consists of an anterior small, short, elongate and thin bifid tooth with more or less equal lobes and a posterior elongate and thin laminate tooth which is connected to the base of the nymphal plate; anterior lateral tooth subproximal, weak and a little pointed; posterior lateral distal and weak. In the right valve, the cardinal complex consists of a posterior slightly skewed, subdeltoid, bifid tooth, whose posterior lobe is the larger and of an anterior deltoid laminate tooth which is adpressed to the base of the lunule; anterior lateral tooth subproximal, strong, pointed, triangular and with a socket above; posterior lateral tooth distal, pointed, weaker than the anterior tooth and with a socket above. The lateral dentition of the right valve is much stronger than that of the left. Sometimes weak radial ribs or vermiculations occur internally, especially in the right valve. Adductor muscle scars not well impressed. Anterior adductor broad and elongate; posterior adductor irregularly subquadrate. Pallial sinus more or less equal in opposite valves, rising only a little behind, generally flattened above, and falling in an arcuation to the pallial line. The sinus does not touch the anterior adductor scar and is generally

well separated from it. Cruciform muscle scars poorly impressed, round and near to the ventral border. Internally and externally, the shell is shining and white, rarely vitreous and suffused with yellow.

length	height	width	
14.0 mm.	13.0 mm.	—	Bermuda
8.5	7.3	4.8 mm.	Bahia Honda Key, Florida
8.3	7.2	4.6	Swan Island, Caribbean Sea
6.2	5.3	2.4	North Rock, Bermuda, in 4 fathoms

Remarks. This species is most closely related to *Strigilla pisiformis* and is included with it in the subgenus *Pisostrigilla*. Both are easily distinguished from all other Western Atlantic *Strigilla* by the nature of the flexures of the oblique sulci along the posterior dorsal slope. Normally, *S. mirabilis* has four or more flexures on the posterior slope, whereas *pisiformis* has only a single zig zag flexure. Furthermore, in *mirabilis*, the pallial sinus is most often separated from the anterior adductor muscle scar, the surface of the valves has more widely spaced sulci, the hinge has more protuberant cardinal teeth, and the shell is thinner. The umbos of *mirabilis* are more pointed than the inflated, rounded and blunt umbos of *pisiformis*. The color of *mirabilis* is almost always white while *pisiformis* is generally maculated with red.

Certain characters of *mirabilis* are variable. The strength of the sculpture varies as well as the extent of the dorsally bowed flexure on the anterior slope and the smooth tract which often replaces it. The posterior dorsal sculpture, which is of prime importance in the identification of this species, is often dissimilarly expressed in opposite valves, and may be stronger and more easily discerned in the right valve.

Strigilla mirabilis is closely related to *S. lenticula* 'Philippi' Hertlein and Strong of the Eastern Pacific. Olsson (1961) has recently shown that the posterior sculpture of true *lenticula* Philippi (= *ervilia* Philippi) is unlike that of *mirabilis* and that it is indeed similar to the type found in the nominate subgenus.

This species is one of the two Western Atlantic *Strigilla* which have been well pre-preserved in the fossil record. So-called Oligocene and Miocene precursors include *S.*

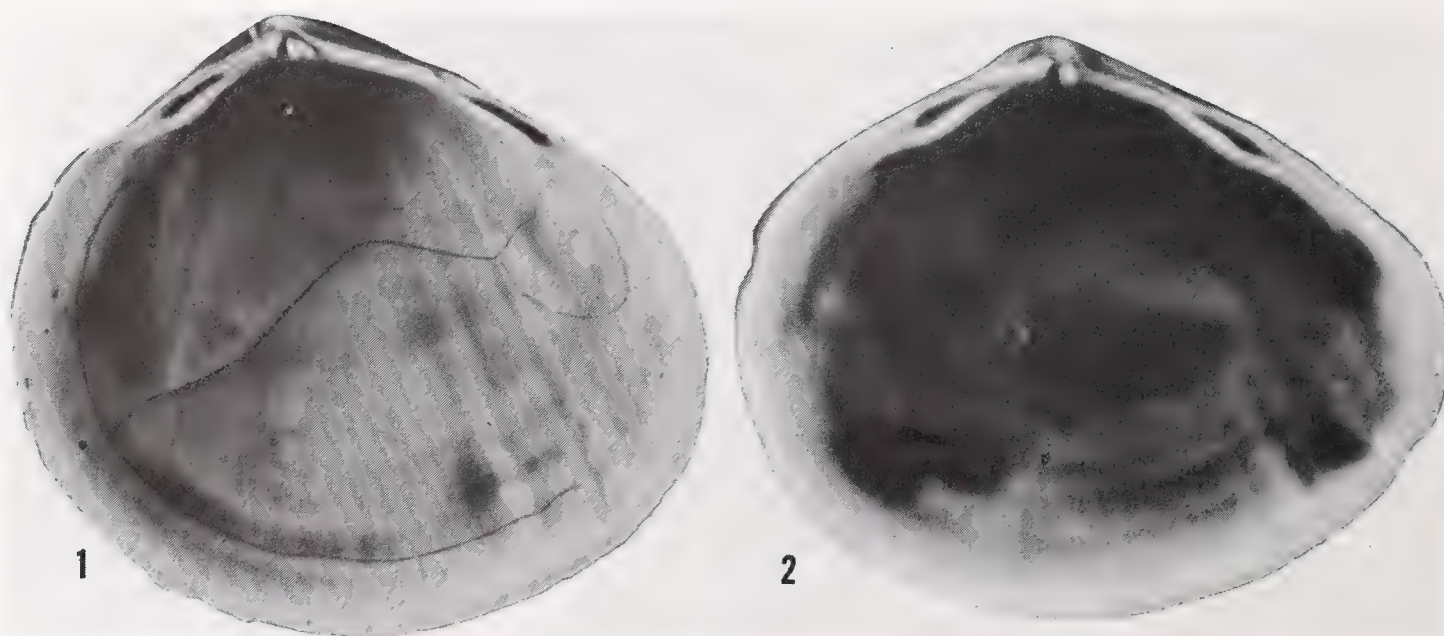


Plate 171. Fig. 1. *Strigilla mirabilis* Philippi, MCZ 223466, Bermuda (right valve internal; about 6.5x).
Fig. 2. *Strigilla producta* Tryon, Syntype, ANSP 53377, Jamaica (right valve internal; about 10x).

eutykta Gardner and Aldrich from the Miocene of Williamston, North Carolina, and *S. georgiana* Gardner and *S. paraflexuosa* Gardner from the Alum Bluff of Florida. *Strigilla sphaerion*, although somewhat atypical and thought by Gardner to be completely unlike any other modern Western Atlantic *Strigilla*, also seems to be related to *mirabilis*. Dall considered his Tertiary specimens as *S. flexuosa* (= *mirabilis*), listed the fossil localities, and further indicated that post-Pliocene or Pleistocene specimens could be found in North and South Carolina. Pleistocene and Pliocene records have been cited by Holmes (1860) and Richards (1962) for South Carolina and by Olsson and Harbison (1953) for Florida. Parker (1956) has indicated its occurrence in the Mississippi Delta Region since the Miocene.

Range. From off Cape Hatteras, North Carolina, this species extends southward through the Greater and Lesser Antilles to Grenada. It is also found in the Gulf of Mexico as far south as Isla Mujeres, Yucatan, Mexico.

Specimens examined. NORTH CAROLINA: *Albatross* Stations 2277, 2112, 2276, 2273, 2272, 2597, 2598, off Cape Hatteras, in 15–22 fathoms (all USNM); *Albatross* Stations 2607, 2608, 2611, off Cape Lookout, in 18–31 fathoms (all USNM); off Beaufort, in 6–9 fathoms; Wrightsville Beach, New Hanover County (both MCZ). SOUTH CAROLINA: Sullivan's Id.; Seabrook Beach; Morris Id. (all CM). FLORIDA: off Palm Beach, in 10–130 fathoms; off Ocean Ridge, Palm Beach, in 7–10 fathoms (both ANSP); S. Inlet of Lake Worth (MCZ); Boynton Beach; Miami (both ANSP); *Albatross* Station 2646, in 85 fathoms, off Cape Florida; 12 miles E of Frying Pan Shoals, in 12 fathoms; Conch Key, in 1–5 feet (all USNM); Grassy Key (ANSP); Bahia Honda Key (ANSP; MCZ); Snipe Key; Boca Chica Key (both ANSP); Newfound Harbor Key (USNM); Key West (USNM; ANSP); Charlotte Harbor; Boca Grande Key (both USNM); Long Key (MCZ); Cedar Keys (USNM); St. Joseph Bay (ANSP); Pensacola (USNM; MCZ). ALABAMA: Fort Morgan (MCZ). MISSISSIPPI: Horn Island (ANSP). TEXAS: Port Aransas; Padre Island, 30 miles SW of Port Aransas (both MCZ). MEXICO: Veracruz; Isla Mujeres (both MCZ). BERMUDA: Bermuda (subfossil, BMNH); Castle Road, Castle Harbour, in 4–5 fathoms; North Rock, 11 miles N of Hamilton (both MCZ). BAHAMA ISLANDS: Moraine Cay, Little Abaco; Dick's Point, Nassau, New Providence; Leafy Cay Beach, Eleuthera (all MCZ); Little San Salvador (ANSP; MCZ); Orange Creek, and Arthurstown, Cat Island (both MCZ); Rum Cay (USNM); Matthews Town, Great Inagua (MCZ; ANSP). CUBA: *Barrera* Station 211, Cape Cajon (USNM); Arenas de la Chorrera, Habana; Pueblo Nuevo, Matanzas Bay (both MCZ); Cayo Blanco, Cardenas Bay (ANSP); Caibarien, Las Villas; Guarda la Vaca, Banes; mouth of Rio Arimao, 12 miles E of Cienfuegos (all MCZ). HISPANIOLA: SANTO DOMINGO: Bahia de Samana (USNM). PUERTO RICO: Bahia de Añasco (MCZ); San Juan Harbour (ANSP; USNM). VIRGIN ISLANDS: Devil's Bay and The Baths, Virgin Gorda; Monkey Point, Guana Island (all MCZ); St. Croix (ANSP). LESSER ANTILLES: Anguilla; Barbuda (both BMNH); English Harbour and Falmouth Harbour, Antigua (both USNM); Guadeloupe; Union, Admiralty Bay, Bequia Island, The Grenadines; Granada (all MCZ). CARIBBEAN ISLANDS: Swan Island (MCZ).

BIBLIOGRAPHY

- Dall, W.H. 1900a. Synopsis of the family Tellinidae and of the North American species. *Proc. U.S. Nat. Mus.*, **23**: 285-326, pls. 2-4.
- Dall, W.H. 1900b. Tertiary fauna of Florida. *Transactions of the Wagner Free Institute of Science of Philadelphia*, **3**(5): 1002-1039.
- Dodge, H. 1952. A historical review of the mollusks of Linnaeus. Part 1. The Classes Loricata and Pelecypoda. *Bull. Amer. Nat. Hist.*, New York, **100**(1): 1-264.
- Gualtieri, N. 1742. *Index testarum conchyliorum quae adservantur in Museo Gualtieri*. Florence, Italy, 23 pp., 110 pls.
- Holmes, F.S. 1860. Post-Pleiocene fossils of South Carolina. Charleston, S.C., 128 pp., 28 pls.
- Lister, M. 1678. *Historiae Animalium Angliae*. London, 250 pp., 9 pls.
- Lister, M. 1770. *Edition Altera. Historiae sive synopsis methodicae conchyliorum*. Oxonii.
- Maury, C.J. 1917. Santo Domingo type sections and fossils. *Bull. Amer. Paleontology*, **5**(29): 419-459.
- Maury, C.J. 1925. A further contribution to the paleontology of Trinidad. *Bull. Amer. Paleontology*, **10**(42): 152-402.
- Maury, C.J. 1934. Fossil invertebrata from NE Brasil. *Bull. Amer. Mus. Nat. Hist.*, **67**(4): 123-179.
- Mazyck, W.G. 1913. *Catalogue of Mollusca of South Carolina*. Contrib. no. 2, Charleston Museum, 39 pp.
- Olsson, A.A. 1961. Mollusks of the Tropical Eastern Pacific. Panamic-Pacific Pelecypoda. *Paleontological Research Inst.*, Ithaca, N.Y., 574 pp., 86 pls.
- Olsson, A.A., and A. Harbison. 1953. Pliocene Mollusca of southern Florida. *Acad. Nat. Sci. Philadelphia*, Monograph 8, pt. 1, 361 pp.
- Olsson, A.A., and T. McGinty. 1958. Recent marine mollusks from the Caribbean coast of Panama. *Bull. Amer. Paleontology*, **39**(177): 1-58, 5 pls.
- Parker, R.H. 1956. Macro-invertebrate assemblages as indicators of sedimentary environments in east Mississippi delta region. *Bull. Amer. Assoc. Pet. Geol.*, **40**(2): 295-376.
- Ravenel, E. 1885. Tellinidae of South Carolina. *Proc. Elliot Society*, **2**(5): 33-40.
- Richards, H.G.. 1962. Studies on the marine Pleistocene, pts. 1 & 2, *Trans. Amer. Phil. Soc. Philadelphia*, New Ser., **52**(3): 5-141, 21 pls.
- Woodring, W.P. 1925. Miocene mollusks from Bowden, Jamaica. Pelecypods and Scaphopods. *Carnegie Inst. Washington*, Publ. no. 366, 222 pp., 28 pls.

BOOK REVIEW

Traité de Zoologie. Anatomie—Systematique Biologie. Tome V. Fascicule III, Mollusques Gastéropodes et Scaphopodes. par E. Fischer, A. Franc, M. Marjota, et G. et H. Termier. 1968. Masson et Cie. Libraires de l'Académie de Médecine. 120 Boulevard Saint-Germain, Paris (VI^e). 286 francs, and 1083 pages and 517 figs.

This work constitutes the second volume on mollusks to appear in the *Traité*. The major portion of the text is by Professor André Franc and considers the Class Gastropoda. After a general introduction to the features of the class, including a discussion of coiling, torsion and asymmetry, which incorporates the latest theories, each of the three subclasses, the Prosobranchia, Pulmonata and Opisthobranchia, are considered in detail. The treatment accorded each group begins with a discussion of external morphology; the shell, if present, the head, and the foot. An elaboration of the anatomical organization follows (very often discussed at the familial or ordinal levels) and includes descriptions of the integument and musculature and the respiratory, digestive, circulatory, excretory, reproductive, and nervous systems. Functional aspects are treated in a section on physiology. Where particular morphological features are of importance in classification, special stress and greater detail are offered. Thus, the nervous systems of the Pulmonata and Opisthobranchia, and the reproductive and digestive systems in the Prosobranchia receive extended discussion.

The systematic section for each group is generally preceded by brief remarks on distribution and ecology; there are no maps or analyses of zoogeographical data. The higher taxa—orders, superfamilies, families and, occasionally, subfamilies—are characterized, while genera and representative species with their geographic range are listed. Phylogenetic and evolutionary relationships, are not elaborated and mechanisms of speciation receive scant attention, although some work on genetics is mentioned. The line-cut illustrations, both in the anatomical as well as the systematic sections, are good and the color plate which illustrates some sacoglossans and nudibranchs is outstanding. However, additional, and more varied, drawings of pulmonates might have been included; those used were largely taken from the works of von Benthem Jutting and Burch and Patterson.

In his treatment of the opisthobranchs, the author relied heavily on a manuscript of Odhner. Thus, there are numerous new families described here as well as at least one new genus. It is annoying (particularly to a taxonomist) to see new familial names replace old ones without explanation. Unfortunately the citation of the author and date with each family is not consistently included.

The bibliographies cite most of the more recent works and are really supplements to the compilations of Simroth and Hoffmann in the respective volumes of Bronn's *Tierreich*.

An outstanding section is the discussion of parasitic and commensal gastropods. The reader will become acquainted with the little known works of two Russian specialists, Ivanov and Grusov, and will be surprised to discover that the largest (longest) gastropod known is *Parenteroxenos doglieli*, an entoconchid which lives in the body cavity of a holothurian and measures some 130 cm. in length and only 5 mm. in diameter.

The chapter on the Class Scaphopoda by Professors E. Fischer-Piette and A. Franc

presents a résumé of information of external morphology and internal anatomy of the tusk shells.

The two remaining sections differ in character, subject and authors. Martoja has written an extensive review article on neurosecretory cells and endocrine glands in mollusks (excepting the cephalopods). The bibliography of this article and its addendum should be helpful to the serious student of molluscan neurophysiology. The brief discussion of the evolution and paleontology of the gastropods by Termier and Termier adds little to the extensive, more thorough treatment in Moore's *Treatise on Invertebrate Paleontology*.

—KENNETH J. BOSS

* * * *

Abbott, R.T. 1968. Seashells of North America: A Guide to Field Identification. A Golden Field Guide, New York, 280 pages and numerous colored illustrations. This guide considers the marine mollusks of both coasts of North America with brief descriptions and colored figures of some 850 species. The introduction covers descriptive details on the major groups of mollusks, their evolutionary history and much about their development. Other subjects covered are the environmental niches, dispersal factors, and consideration of the marine faunal provinces in which they occur.

The excellent illustrations are by George F. Sandström, several of which show the animal as it appears alive. —W. J. CLENCH

JUL 1 1970

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Published by
THE DEPARTMENT OF MOLLUSKS
Museum of Comparative Zoölogy, Harvard University
Cambridge, Massachusetts

JUNE 29, 1970

REVIEW NUMBER

VOL. 4, NO. 48

The material published in this Review Number is but a small part of the new information available on the various species covered in JOHNSONIA. However, space is limited and so we are restricting it to certain pertinent new data in the Volutidae and Conidae.

THE FAMILY VOLUTIDAE IN THE WESTERN ATLANTIC

BY

W. J. CLENCH AND R. D. TURNER

Since the publication of the Volutidae (no. 43) we have received several specimens which now allow us to figure the radulae of two species for the first time, to give some range extensions, and to figure the egg case and young of *Voluta musica* Linnaeus.

Voluta musica Linnaeus

Plate 172, figs. 1-3; Plate 173, fig. 3

Voluta musica Linnaeus. Clench and Turner 1964, Johnsonia 4: 140, pl. 84, fig. 13; pl. 85, figs. 1-3.

Remarks. While collecting at Playa Chiquito, Curaçao, Netherlands Antilles, Robert C. Bullock found the egg case of this species fastened to the underside of a coral slab in about 3 meters of water. It contained three young, nearly ready to emerge. These along with the egg case and the radula of the young are figured. The radula has only 12 teeth and these are proportionately narrower and have fewer denticles than the adult (Plate 173, fig. 3). The operculum is well formed, similar to that of the adult but exceedingly thin. The digestive system at this stage is completely formed, and while dissecting out the radula it was possible to identify all of the organs illustrated for the adult in Johnsonia no. 43, Plate 82, fig. 18. There is no question that the young are ready to feed immediately upon emerging from the egg case.

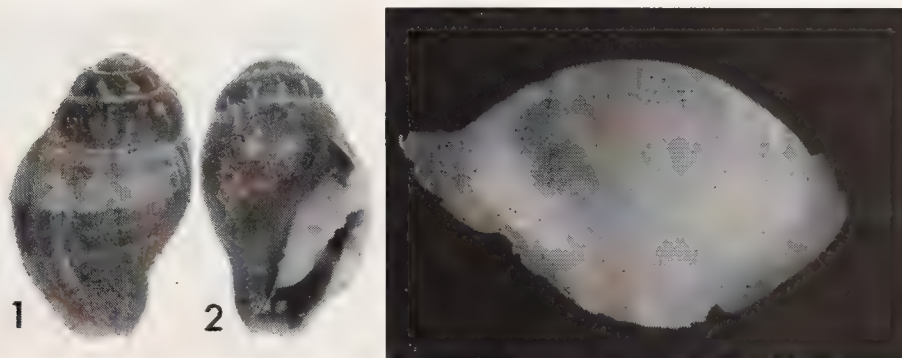


Plate 172. *Voluta musica* Linnaeus. Playa Chiquito, Curaçao, Netherlands Antilles. Young shells and the egg capsule from which they were removed. (Figs. 1-2, 3x; egg capsule 2.3x.)

Voluta virescens Solander

Plate 173, fig. 4

Voluta (?) *virescens* Solander. Clench and Turner 1964, *Johnsonia* 4: 146, pls. 82, 84.

Remarks. At the time we monographed this species, we had not seen any preserved material. Through the kindness of Clifton S. Weaver we received the soft parts of a specimen of *virescens* obtained from the northern part of the Gulf of Mexico. The specimen was too poorly preserved for detailed anatomical work, but it was possible to determine that the radula is typical of the genus. It differs only in being very much smaller, the width being only 0.2 mm., the entire radula being less than 3 mm. in length.

Specimens examined. TEXAS: about 50 miles SE of Port Aransas in 146 meters (Clifton Weaver).

Zidona dufresnei (Donovan)

Zidona dufresnei (Donovan). Clench and Turner 1964, *Johnsonia* 4: 147, pls. 82-83; 88-91.

Specimens examined. BRASIL: Camboriu; Itapema; Penha, all Estado Santa Catarina (all São Paulo Museum).

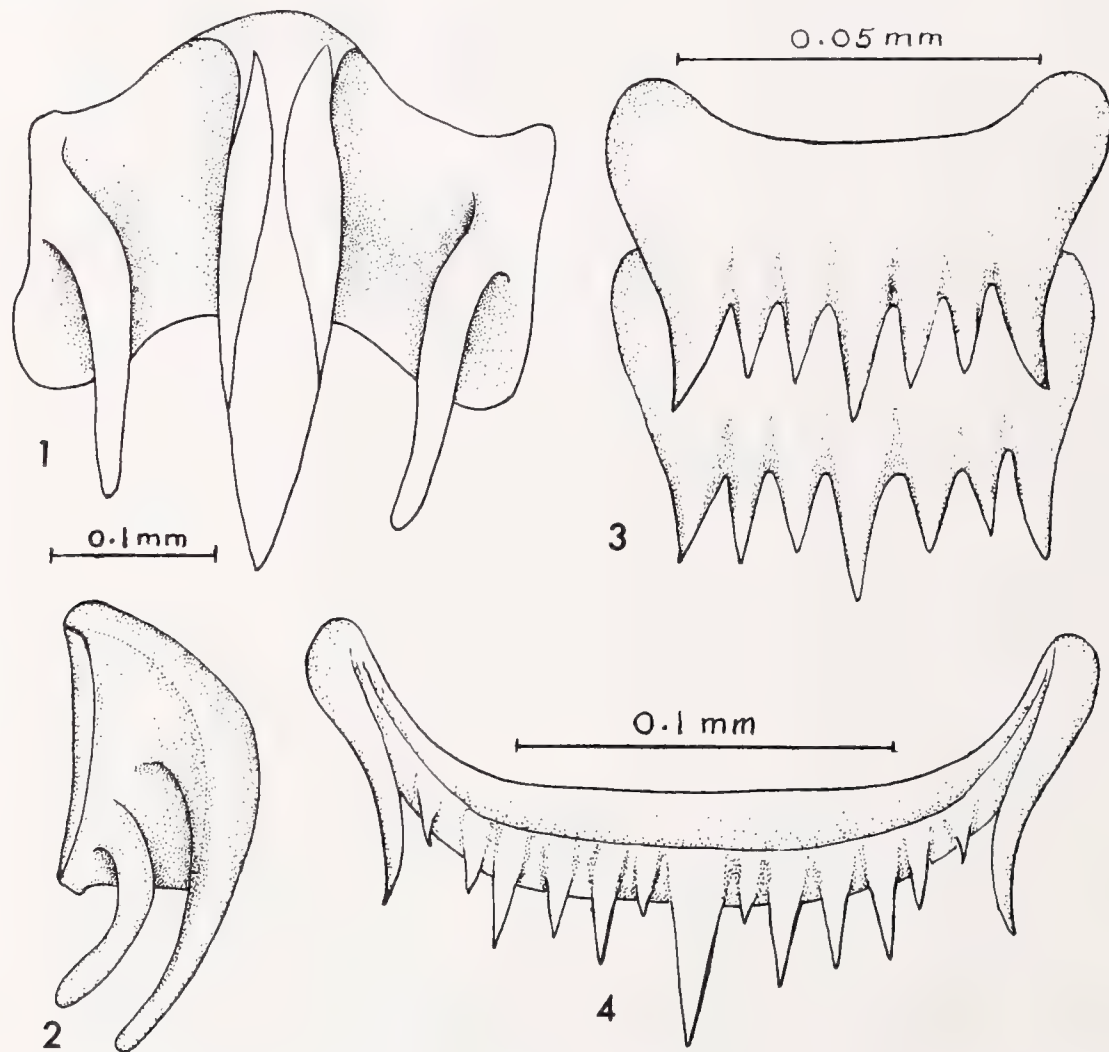


Plate 173. Radulae of Volutidae. Figs. 1-2. Front and side view of single tooth of *Odontocymbiola subnodosa* (Leach), from off Punta Médano, Argentina, in 91.4 meters. Fig. 3. Two teeth from the young *Voluta musica* Linnaeus figured on Plate 172, fig. 2. Fig. 4. Single tooth of *Voluta virescens* Solander from 50 miles SE of Port Aransas, Texas, in 146 meters.

***Odontocymbiola subnodosa* (Leach)**

Plate 173, figs. 1-2; Plate 174, figs. 1-2

Adelomelon (?) *subnodosa* (Leach). Clench and Turner 1964, *Johnsonia* 4: 155, pls. 95-96.

Remarks. At the time we considered this species, we did not have any preserved material for study and there were no published reports concerning the radula. Consequently our previous generic assignment was tentative. In September 1966, Dr. E. de Carvalho Rios of the Museu Oceanográfico, Rio Grande do Sul, Brasil, sent us a preserved specimen. The radula, here figured, proved to be that of an odontocymbolid and not an *Adelomelon* as we had thought on the basis of the shell only.

This is the fourth known species in this genus which is restricted to the east coast of South America from Brasil south to Argentina and the Falkland Islands.

Specimens examined. ARGENTINA: off Punta Médano, Prov. Buenos Aires, in 91.4 meters (Leopold Pontes).



Plate 174. *Odontocymbiola subnodosa* (Leach). From off Punta Médano, Prov. Buenos Aires, Argentina, in 91.4 meters (nat. size).

***Scaphella* (*Scaphella*) *junonia* (Lamarck)**

Voluta junonia 'Chemnitz' Lamarck 1804, Ann. Muséum National d'Histoire Naturelle 5: 156 (no locality given) [refers to Chemnitz 1795, Conchylien-Cabinet (1) 11: 16, pl. 177, figs. 1703-1704].

Scaphella (*Scaphella*) *junonia* (Shaw). Clench 1946, *Johnsonia* 2: 49, pl. 28, figs. 1-3.

Remarks. The Lamarck reference given above predates that of Shaw 1808 in *The Naturalists Miscellany* 19: 815, pl. 5. Therefore, though there is no change in name of this species, the authority for *junonia* is Lamarck, not Shaw as used in JOHNSONIA no. 22.

* * * * *

THE GENUS CONUS IN THE WESTERN ATLANTIC

BY

WILLIAM J. CLENCH AND ROBERT C. BULLOCK

The genus *Conus* was treated previously in JOHNSONIA 1, no. 6. The Review Number of vol. 2 (1953) summarized the new species and geographic data which had accrued since 1942. However, so much work has been done since 1953 that a new revision of the Conidae is needed. Further ecologic and life history studies, as well as much additional material, are necessary to clarify the many problems in this complex family. In the present number we only add information concerning a few species already treated and report on three species not previously covered in JOHNSONIA.

Conus centurio Born

Plate 175

Conus centurio Born. Clench 1942, Johnsonia 1 (6): 24, pl. 12, fig. 1.

Remarks. At the time this species was treated in JOHNSONIA, only a single specimen with precise locality data was available. Through the kindness of Peter Percharde we have received one of five specimens that he collected by SCUBA diving off Miramar

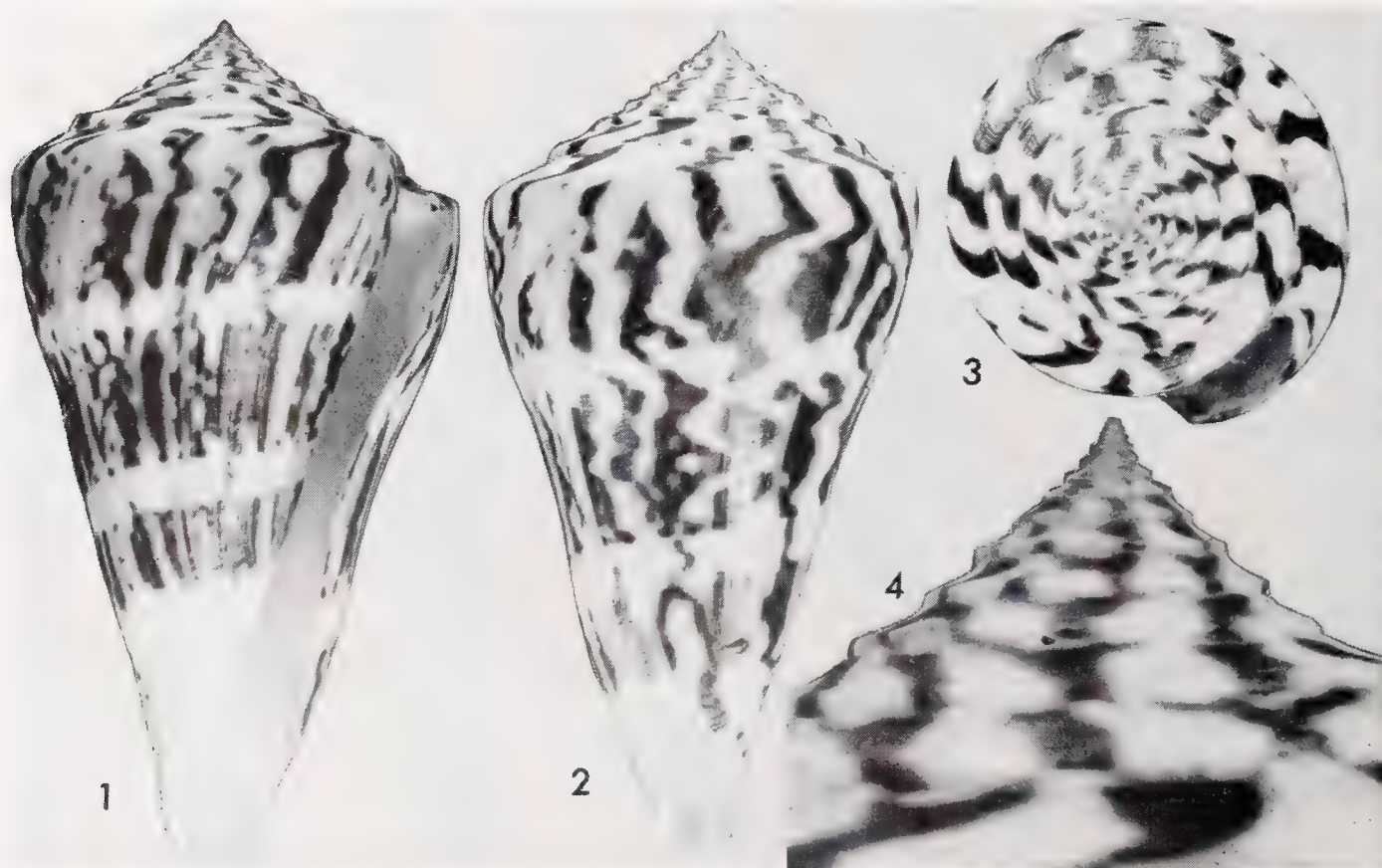


Plate 175. *Conus centurio* Born. Figs. 1-4. Off Miramar Bay, Boca de Monas, Trinidad, in 46-49 meters. Figs. 1-2 (nat. size). Fig. 3. Apical view to show anal notch (nat. size). Fig. 4. Enlargement of apex (3.3x).

Bay, Boca de Monas, Trinidad, in 150–160 feet (46–49 meters). Mr. Percharde (in litt.) described the collecting site as “a flat, silty ledge, 260 feet long by 60 feet wide.” He said that, when at rest, *C. centurio* is practically buried in the silt. The specimen sent to us was found feeding on a *Cyphoma intermedium* and the body of one was found in the “gullet.” The proboscis of *C. centurio* is bright sulfur yellow. He also noted that *C. centurio* was found in association with *Conus insularis* Gmelin, *Murex cabritii* Bernardi, *Polystira albida* (Perry), and numerous specimens of *Cyphoma intermedium* (Sowerby).

The operculum is unguiculate, 21 mm. long and 5 mm. wide with rather sharp concentric ridges. It is approximately one-fourth the length of the aperture.

length	width	whorls
91 mm.	49 mm.	15

Conus hieroglyphus Duclos

Plate 176, figs. 1–5

Conus hieroglyphus Duclos 1833, Magasin de Zoologie, Journal **3**: classe V, pl. 23 (locality unknown; type extant?).

Conus hieroglyphicus [sic] Duclos. Reeve 1843, Conchologia Iconica **1**: *Conus*, pl. 18, figs. 101a–b; Deshayes and Milne Edwards 1845, Animaux sans Vertèbres, 2nd ed. **11**: 140–141; Kiener 1848, Iconographie Coquilles Vivantes **2**: 181, pl. 73, figs. 1–1a; Sowerby 1858, Thesaurus Conchyliorum **3** (part 18): 47, sp. 402, *Conus*, pl. 14, figs. 318–319; Weinkauff 1875, [in] Martini-Chemnitz, Systematisches Conchylien-Cabinet **4** (2): 305, pl. 54, figs. 9–10; Usticke 1968, Caribbean Cones, p. 27, fig. 1018. [All are spelling errors for *C. hieroglyphus* Duclos, 1833.]

Conus armillatus C. B. Adams 1850, Contributions to Conchology, no. 4, p. 59 (Jamaica) [Lectotype USNM 107876]; Clench and Turner 1950, Occasional Papers On Mollusks **1**: 258 [not pl. 31, fig. 10]; Abbott 1958, Nautilus **71**: 117–118; Abbott 1962, Sea Shells of the World, p. 118; Wagner and Abbott 1967, Standard Catalog of Shells, 2nd ed., p. 178 [name only]; Van Mol, Tursch, and Kempf 1967, Ann. Inst. Oceanogr., Monaco **45**: 251, fig. 14.

[?] *Conus mindanus* Hwass. Krebs 1864 [in part], The West-Indian Marine Shells, p. 3; [republished] Clench, Aguayo and Turner 1947, Revista Soc. Malacologia “Carlos de la Torre”, Museo Poey, Univ. de la Habana, **5**: 25.

Conus proteus Hwass. Weinkauff 1875 [in part], Systematisches Conchylien-Cabinet **4** (2): 392; Tryon 1884 [in part], Manual of Conchology **6**: 12.

Conus regius Gmelin. Clench 1942 [in part], Johnsonia **1** (6): 3.

Conus perryae ‘Clench’ Coomans 1958, Studies Fauna Curaçao **8**: 100, pl. 14 (top right) [non *C. perryae* Clench 1942].

Conus aurantius Hwass. Wagner and Abbott 1967 [in part], Standard Catalog of Shells, 2nd ed., p. 179.

Description. Shell small, reaching 15.4 mm. in length and 8.6 mm. in greatest diameter. Whorls $7\frac{1}{2}$, slightly convex, shoulder rounded. Background color white with variable covering of brownish black and reddish brown splotches. Beach-worn specimens lighter in color, sometimes lavender. Spiral threads faint, beaded, white. Aperture white, pinkish, or violet, moderately wide, broadening somewhat anteriorly. Spiral sculpture of 4–6 rather even, closely packed cords on the sutural ramp, and finer, more widely spaced, beaded cords on the body whorl. Anteroventral portion of the shell with spirally incised grooves, white, pink, or violet, and characteristically devoid of the normal color pattern. Periostracum thin, translucent straw-yellow, slightly thickened over the spiral cords, with barb-like projections on the whorl shoulder.

length	width	
15.4 mm.	8.6 mm.	Aruba, Netherlands Antilles
14.1	8.2	Lectotype of <i>C. armillatus</i>

Remarks. The confusion regarding the unique specimen considered as the holotype of *C. armillatus* by Clench and Turner (1950) was discussed by Abbott (1958a). Having examined this specimen (MCZ 154005), we agree with Abbott that it is a worn *Conus regius* Gmelin and that it cannot be considered a type. However, C. B. Adams sent a specimen of *C. armillatus* to the United States National Museum. The USNM label reads "*Conus armillatus* C. B. Ads. / Jamaica. C. B. Ads." and an entry in the catalogue reads "Type." Since characteristics of this specimen (USNM 107876) agree with the original description and since it is from the type series, it is here designated as the lectotype of *Conus armillatus* C. B. Adams (Plate 176, fig. 5).



Plate 176. Figs. 1-4. *Conus hieroglyphus* Duclos. Figs. 1-2. From northern tip of Aruba, Netherlands Antilles. Fig. 3. Aruba. Fig. 4. Copy of type figure of *hieroglyphus* from Duclos 1833, pl. 23. Fig. 5. Lectotype of *Conus armillatus* C.B. Adams 1850 (USNM 107876). Fig. 6. Paratype of *Conus selenae* Van Mol, Tursch, and Kempf from off Fortaleza, Ceará, Brasil (MCZ 278239). Figs. 1, 3-6 (2.9x). Fig. 2 (6.3x).

Conus armillatus has been associated, in the literature, with *C. hieroglyphus* Duclos, 1833. All specimens called *C. hieroglyphicus* [sic] Duclos appear to be conspecific with *C. armillatus*. From an examination of the type figure of *C. hieroglyphus* (Plate 176, fig. 4) we concluded that this species is synonymous with *C. armillatus*. Wagner and Abbott (1967) listed *C. hieroglyphus* as a junior synonym of *C. aurantius* Hwass, another Caribbean species. Holeman (1969) stated "The type [Duclos collection specimen ?] of *Conus hieroglyphus* Duclos has been located and is *C. aurantius* Hwass," but did not furnish any proof. There appear to be several significant differences between the two species. The Duclos figure of *C. hieroglyphus* has rather convex whorls, completely lacks knobs on the whorl shoulder, and shows the anteroventral portion of the shell with spirally incised grooves and devoid of the normal color pattern. Duclos mentioned that the interior of the aperture was light violet. These features are characteristic of *C. armillatus*, not *C. aurantius*, and therefore we consider the former a synonym of *hieroglyphus*.

The following account is offered to explain some of the confusion concerning *C. hieroglyphus*, though additional data will undoubtedly clarify the issue. Ten years after the

original description, Reeve (1843: **Conus**, sp. 101) claimed that the Duclos description was made possible by devious means, when he wrote:

I feel exceedingly obliged to M. Deshayes for the loan of this interesting Cone, because it enables me to expose one of the most flagrant examples of dishonesty that ever disgraced the annals of conchological science. The shell now before me was borrowed of M. Deshayes by M. Duclos under the pretext of comparing it with a specimen of much larger dimensions in his own cabinet. There was no such specimen, however, in existence; the drawing given by M. Duclos as of one in his collection is indisputably a magnified representation of this, so that he adopted this discreditable manoeuvre merely to gain the credit of having introduced a new species of Cone. I should not have ventured to publish or to speak so positively of this notorious imposition; but there are certain particular marks in the figure and in the shell by which it may be detected. I am thus obliged to believe as true (and in duty bound to expose), what I have hitherto ridiculed as incredible.

Duclos had stated that his specimen was 36 mm. long and that Deshayes possessed a smaller specimen 22 mm. long. Deshayes probably informed his contemporaries, including Reeve, about what he felt had happened, for Deshayes and Milne Edwards (1845) wrote that *Conus hieroglyphicus* [sic] was known only from one specimen. Further, they said that "the figure given by M. Duclos, in the *Magasin de Zoologie*, represents the individual of our collection, but made larger."

Numerous authors, beginning with Reeve (1843) and Deshayes and Milne Edwards (1845) have referred to *C. hieroglyphus* as *C. "hieroglyphicus."* Tomlin (1939), in his catalogue of the Recent and fossil cones, was the first author to revert to the correct spelling. However, the identity of *C. hieroglyphus* remained a mystery. Duclos thought that it may have come from California. Sowerby (1858) figured two color varieties from the West Indies and perhaps it is for this reason that Tryon (1884) gave the locality as "? West Indies." Recently, Usticke (1968) recognized that *C. hieroglyphicus* [sic] was conspecific with *C. armillatus*.

Range. Reported from Jamaica and Aruba.

Specimens examined. JAMAICA: (USNM). CARIBBEAN ISLANDS: Aruba (H.G. Wiswall); northern tip of Aruba; Malmok, Aruba; Boca Grande, Aruba (all MCZ).

***Conus aurantius* Hwass**

Plate 177, figs. 1-3

Conus aurantius Hwass 1792, [in] Bruguière, *Encyclopédie Méthodique* 1: 606, pl. 317, fig. 7 (Philippines [erroneous—here corrected to Curaçao, Netherlands Antilles]) [Lectotype in Muséum d'Histoire Naturelle de Genève, no. 1106/42]; Coomans 1963, *American Malac. Union Ann. Rept.* for 1963, p. 9; Seamon and Seamon 1967, *Hawaiian Shell News* 15 (12): 1, 8, figs. 1-4; Kohn 1968, *Journ. Linn. Soc. (Zool.)* 47: 414, pl. 2, fig. 9 [Lectotype selected and figured]; Usticke 1968, *Caribbean Cones*, p. 22, fig. 1012; Holeman 1969, *Hawaiian Shell News* 17 (10): 3, figs. 1-3; Van Pel 1969, *Hawaiian Shell News* 17 (10): 5, figs. 1-4.

Description. Shell small to medium, reaching 73.5 mm. in length and 32.5 mm. in greatest diameter. Whorls 10, spire moderately extended, with about 14 obliquely set knobs on the whorl shoulder. In a few specimens the shoulder of the body whorl may be nearly smooth. Color white or light purplish white with prominent irregular markings of orange, gold-brown, or purplish black. Spiral sculpture of numerous node-studded,

white threads with reddish brown markings. On darker specimens the white nodes are seen only on the colored areas. Aperture white to bluish white, broadening slightly near the siphonal canal. Periostracum thin, translucent yellow.

length	width	
73.5 mm.	32.5 mm.	Bonaire
50.7	25.2	Curaçao
49.0	25.0	Lectotype of <i>C. aurantius</i>
23.7	11.3	Aruba

Remarks. *C. aurantius* Hwass has been recorded as an Indo-Pacific species, but recent collecting and reports published during the last decade have shown conclusively that it is a West Indian species.

Wagner and Abbott (1967) and Holeman (1969) stated that *C. hieroglyphus* Duclos, 1833 is a junior synonym of *C. aurantius* (see remarks under *C. hieroglyphus*). The relationship between *C. aurantius* and *C. insularis* Gmelin is uncertain.

Seamon and Seamon (1967:1) reported collecting *C. aurantius* where the water was clear, the bottom of silty sand, coral rubble, and "profuse coral formations." Specimens were found in 10 to 30 feet of water "under huge dead coral heads where the shells were partially buried under sand." Van Pel (1969) recorded finding a black specimen "creeping over an algae field at a depth of 25 feet," but he also found specimens under stones and dead coral in two to four feet of water.

Range. Reported from Aruba, Bonaire, and Curaçao, Netherlands Antilles. Holeman (1969) recorded this species from Grenada and the Grenadine Islands.

Specimens examined. CARIBBEAN ISLANDS: Malmok, Aruba (Bullock); Vaersenbaai, Curaçao (MCZ).



Plate 177. Figs. 1-3. *Conus aurantius* Hwass. Figs. 1-2. Vaersenbaai, Curaçao, Netherlands Antilles. Fig. 3. Malmok, Aruba, Netherlands Antilles. Fig. 4. *Conus insularis* Gmelin, from off Miramar Bay, Boca de Monas, Trinidad, in 46 meters. Figs. 1, 4 (1.2x). Fig. 2 (2.3x). Fig. 3 (2.2x).

Conus insularis Gmelin

Plate 177, fig. 4

Conus insularis Gmelin 1791, Syst. Nat., ed. 13, p. 3389 (no locality).

Conus dominicanus Hwass. Clench 1942, Johnsonia 1 (6): 6, pl. 4, fig. 4.

Conus regius Gmelin. Clench 1942 [in part], Johnsonia 1 (6): 3.

Remarks. At the time the genus *Conus* was monographed in JOHNSONIA, little was known about this species, and Clench (1942) synonymized *C. insularis* with *C. regius* Gmelin. Abbott (1958b) also thought this species to be a variant of *C. regius*. Kohn (1966) pointed out that *C. insularis* is a senior synonym of *C. dominicanus* Hwass, and stated: "In my opinion, *C. insularis* should be considered provisionally valid until study of natural populations elucidates the relationship between it and *C. regius*." Although we feel that *C. insularis* is distinct from *C. regius*, it is closely related to *C. aurantius* Hwass. Further study may prove that *insularis* and *aurantius* are conspecific.

Conus ermineus Born

Plate 178

Conus ermineus Born 1778, Index Rerum Naturalium Musei Caesarei Vindobonensis, p. 141 (Indiis) [Lectotype, Naturhistorisches Museum, Vienna, No. 4051, selected by Kohn (1964)].

Conus guinaicus Hwass 1792, [in] Bruguière, Encyclopédie Méthodique 1: 697 (Guinea) [Lectotype, Muséum d'Histoire Naturelle de Genève, No. 1106/87]. New synonym not included in Johnsonia, no. 6.

Conus ranunculus Hwass. Clench 1942, Johnsonia 1 (6): 32, pl. 15, figs. 6-7; Abbott 1958, Acad. Nat. Sci. Philadelphia, Monog. 11, p. 94.

Remarks. Kohn (1968) studied the species of *Conus* described by Hwass and showed that the holotype of *C. ranunculus* is a beach-worn shell of an Indo-Pacific species, *C. achatinus* Gmelin. Therefore, the name *C. ranunculus* is unavailable for the Atlantic species. Kohn suggested use of the name *C. testudinarius* Hwass (see Clench 1942, cited above), but pointed out that the West African *C. ermineus* Born may be conspecific

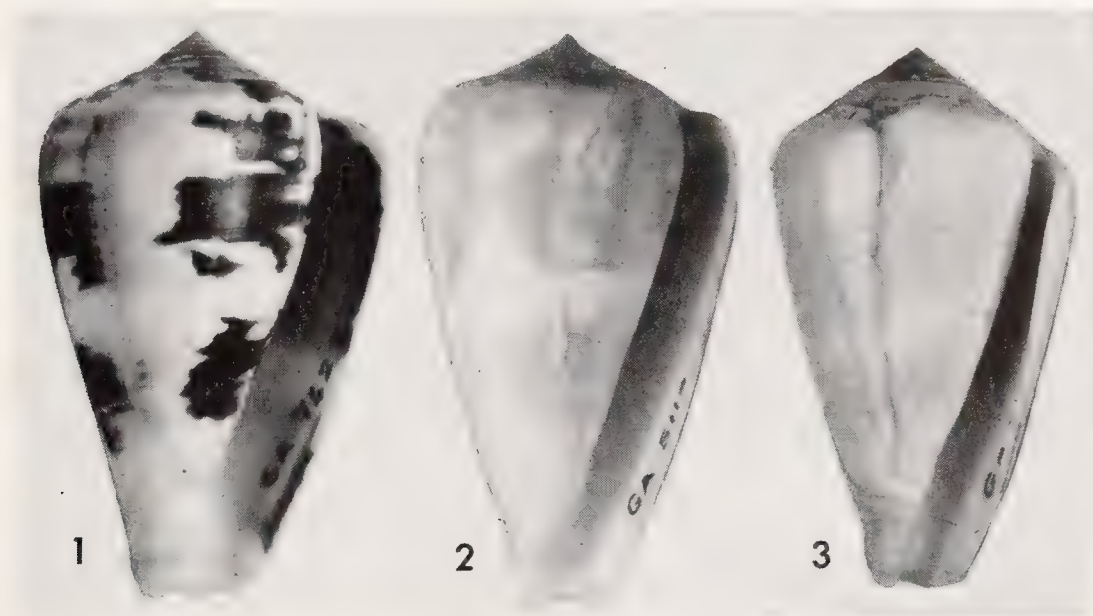


Plate 178. *Conus ermineus* Born, showing color variation. Fig. 1. Bluish white background with reddish brown markings, from silt under the eaves of large rocks, Escondida Cove, Trinidad, in 3-5 meters. Fig. 2. White background with orange markings, from coral reef area, Tyrrel's Bay, Tobago. Fig. 3. White with several faint orange splotches, from a fine silt bottom, Cyril's Bay, Trinidad, in 20-34 meters. Specimens collected by Peter Percharde (all 0.86x).

with the West Indian species. Nicklès (1950) used the name *testudinarius* for the West African species; Clench (1942) and Abbott (1958b) both considered the West African form to be conspecific with the West Indian one. We find no significant differences between the eastern Atlantic and Caribbean forms and conclude that *C. ermineus* is the valid name for this amphiatlantic species.

***Conus selenae* Van Mol, Tursch, and Kempf**

Plate 176, fig. 6

Conus selenae Van Mol, Tursch, and Kempf 1967, Ann. Inst. Oceanogr., Monaco 45: 250–251, pl. 8, figs. 2a–c (Fortaleza, Ceará, Brasil) [Holotype, Muséum National d'Histoire Naturelle, Paris].

Description. Shell moderately small, reaching 19 mm. in length and 11.5 mm. in greatest diameter. Whorls 8, slightly convex, shoulder rounded. Color white with two wide, very light lilac bands flecked with white. Spiral sculpture of faint whitish cords dotted with light reddish brown on the body of the whorl, and 3–4 irregular, beaded spiral cords on sutural ramp. Aperture white to lilac, becoming wider anteriorly. Periostracum very thin, transparent yellow.

Remarks. Van Mol, et al. (1967) mentioned that *C. selenae* differs from all other Western Atlantic *Conus* in the sculpture of the spire. It is distinguished from *C. hieroglyphus* Duclos in having nodular, rather than smooth, spiral cords on the sutural ramp.

Range. Known only from off Recife and Fortaleza, Ceará, Brasil in moderately deep water to 135 meters.

Specimens examined. BRASIL: Fortaleza, Ceará (MCZ).

The following were also described by Van Mol, Tursch, and Kempf (1967), but we have not seen specimens of these species.

***Conus capricorni* Van Mol, Tursch, and Kempf**

Conus capricorni Van Mol, Tursch, and Kempf 1967, Ann. Inst. Oceanogr., Monaco 45: 238, fig. 3 and pl. 10, figs. 1a–b (off Rio Grande, Brasil, 30°40' S; 49°35.5' W, trawled from 141–135 meters at "Calypso" station 150) [Holotype, Muséum National d'Histoire Naturelle, Paris].

***Conus yemanjae* Van Mol, Tursch, and Kempf**

Conus yemanjae Van Mol, Tursch, and Kempf 1967, Ann. Inst. Oceanogr., Monaco 45: 251, fig. 15 and pl. 8, figs. 1a–b (off the mouth of the Rio São Francisco, in 63 meters, "Canopus" station 35, 4°33' S; 37° W). [Holotype, Muséum National d'Histoire Naturelle, Paris].

REFERENCES CITED

- Abbott, R.T. 1958a. Rediscovery of a rare Caribbean *Conus*. *Nautilus* **71**: 117-118.
- Abbott, R.T. 1958b. The marine mollusks of Grand Cayman Island, British West Indies. Acad. Nat. Sci. Philadelphia, Monograph No. 11, 138 pp., 5 pls.
- Abbott, R.T. 1962. Sea Shells of the World. Golden Press, New York. 160 pp.
- Clench, W.J. 1942. The genus *Conus* in the Western Atlantic. *Johnsonia* **1** (6): 1-40, 15 pls.
- Clench, W.J. and R.D. Turner. 1950. The Western Atlantic marine mollusks described by C.B. Adams. Occasional Papers On Mollusks, Harvard University **1**: 233-403, pls. 29-49.
- Deshayes, G. P. and H. Milne Edwards. 1845. [in] Lamarck, Histoire Naturelle des Animaux sans Vertèbres, 2nd ed. **11**: 1-165.
- Duclos, P.L. 1833. [in] Guérin, Magasin de Zoologie, Journal for 1833: Classe V, pl. 23.
- Holeman, J. 1969. Further notes on *Conus aurantius* Hwass, and another mystery. Hawaiian Shell News **17** (10): 3-4, figs. 1-5.
- Kohn, A.J. 1964. Type specimens and identity of the described species of *Conus*. II. The species described by Solander, Chemnitz, Born, and Lightfoot between 1766 and 1786. Jour. Linn. Soc. (Zool.) **45**: 151-167, 2 pls.
- Kohn, A.J. 1966. Type specimens and identity of the described species of *Conus*. III. The species described by Gmelin and Blumenbach in 1791. Jour. Linn. Soc. (Zool.) **46**: 73-102, 3 pls.
- Kohn, A.J. 1968. Type specimens and identity of the described species of *Conus*. IV. The species described by Hwass, Bruguière and Olivi in 1792. Jour. Linn. Soc. (Zool.) **47**: 431-503, 9 pls.
- Nicklès, M. 1950. Mollusques testacés marins de la côte occidentale d'Afrique. Manuels Ouest-Africains **2**, 269 pp., 464 figs.
- Reeve, L. 1842. Monograph of the genus *Conus*. Conchologia Iconica **1**, *Conus*. 47 pls.
- Seamon, N. and E. Seamon. 1967. Observations on the habitat, locality, and range of the rare *Conus aurantius* Hwass 1792. Hawaiian Shell News **15** (12): 1, 8, figs. 1-5.
- Sowerby, G.B. 1857-1858. Monograph of the genus *Conus*. Thesaurus Conchyliorum **3** (part 17), 56 pp., 24 pls.
- Tomlin, J.R. leB. 1937. Catalogue of Recent and fossil cones. Proc. Malac. Soc. London **22**: 205-330, 333.
- Tryon, G.W. 1883-1884. Manual of Conchology (1) **1**, 150 pp., 31 pls.
- Usticke, G.W. Nowell-. 1968. Caribbean cones from St. Croix and the Lesser Antilles. Livingston Pub. Co., Narbeth, Pa., 31 pp., 4 pls.
- Van Mol, J.-J., B. Tursch, and M. Kempf. 1967. Campagne de la Calypso au large des cotes Atlantiques de l'Amérique du Sud (1961-1962). 16. Mollusques Prosobranches: Les Conidae du Brésil. Ann. Inst. Oceanogr., Monaco **45**: 233-255, pls. 5-10, 17 figs.
- Van Pel, P.L. 1969. Additional notes on *Conus aurantius*. Hawaiian Shell News **17** (10): 5, figs. 1-6.
- Wagner, R. and R.T. Abbott. 1967. Standard Catalog of Shells, 2nd ed. D. Van Nostrand Co., Princeton, N.J., 303 pp.

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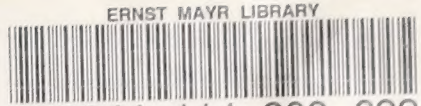
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